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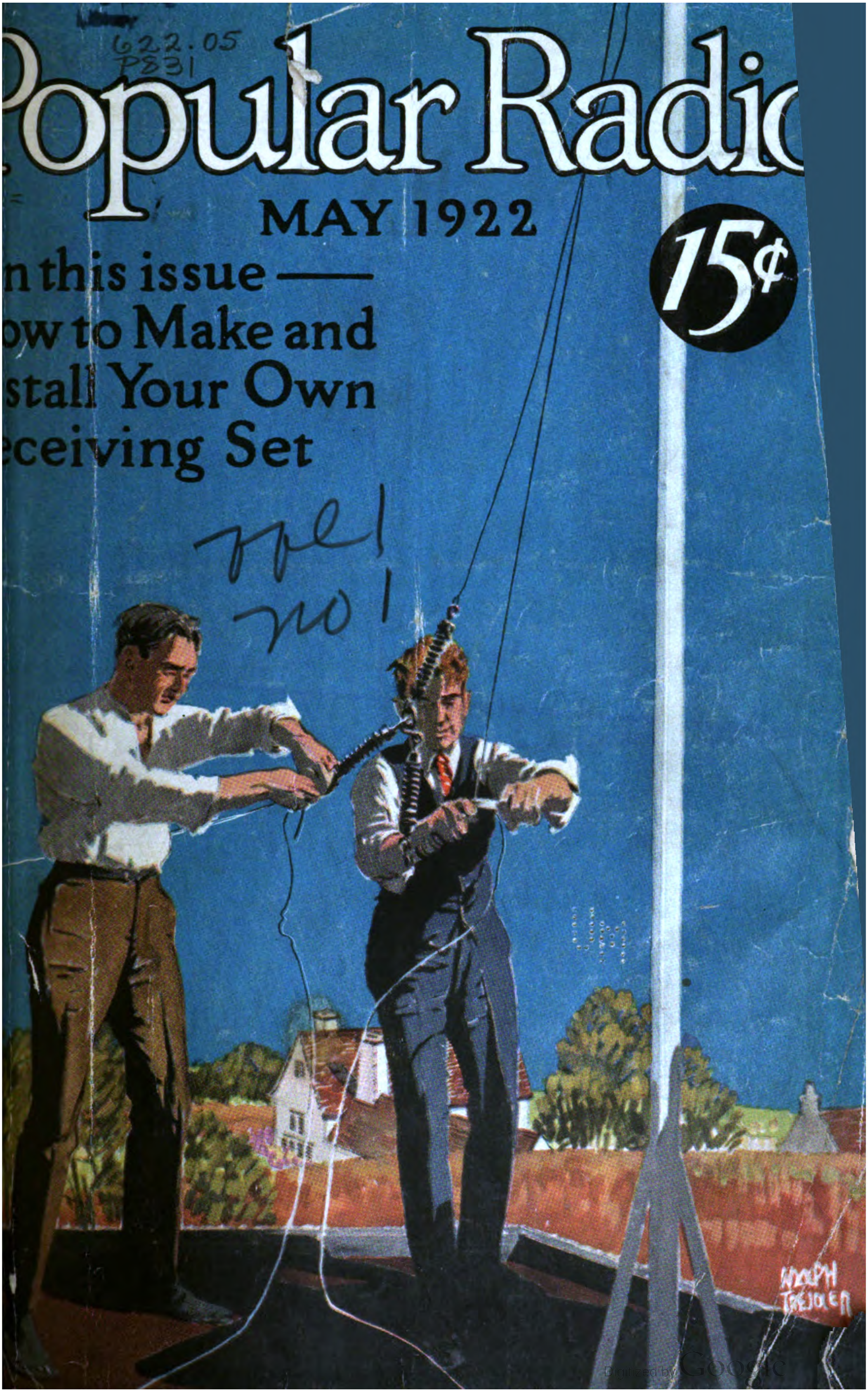

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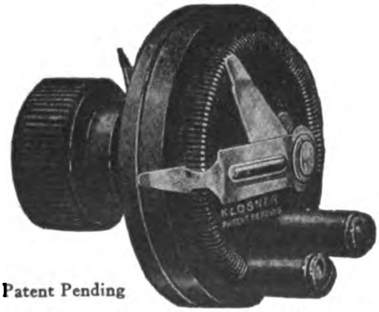

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Herbert Hoover

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Popular Radio

VOLUME I MAY, 1922 NUMBER 1

The American Amateur's Amiable Uncle Samuel

Nowhere in the World Has the Amateur Radio Fan Either Grabbed or Been Given the Chance as Right Here in This Country. How the Foreigner is Restricted by HIS *Government is Told Here by the Far-Traveled War Correspondent—*

WILLIAM G. SHEPHERD

THIS is how a wireless fan in England sends a message: First he writes it out on a very thin piece of tissue paper. He twists this paper into a very tight roll and ties a string around it. Then he goes out into the yard or up on the roof, opens the door of a little shed, ties the message to the leg of a carrier pigeon he finds there and then turns the pigeon loose.

There are hundreds of thousands of these pigeon wireless fans in England. The trouble they go to in order to get a message to a friend is astonishing. It is about a three-day job.

In the first place an English wireless fan can't use one of his own pigeons. He has to get a pigeon from the friend to whom he wants to send a message. That means that he must go to this friend's house to get the bird. Very often he will take one of his own birds to his friend. Every Saturday afternoon in England you will see these wireless fans on the trains carrying cages containing one or two birds. By Saturday evening thousands of birds have been taken to strange places and are crazy to fly home again as soon as they are set free.

On Sunday morning the fans have their fun. They set the birds loose with their messages. Then they keep time on their flights. If my bird gets to my home sooner than your bird to yours, then I have the better bird. The fans exchange records by mail and by Monday or Tuesday everybody knows whether the other fellow got his message or not. For over half a century this carrier-pigeon fad has been in vogue in England. There are carrier-pigeon societies and carrier-pigeon magazines and shops that carry carrier-pigeon supplies.

And the carrier-pigeon fan is the nearest thing they have to a wireless amateur in England.

THE laws against the wireless amateur in England are so strong that there's hardly any use of a young man either making or buying an outfit.

I know a young man in England who is

a wireless amateur. He has plenty of money, for his father is rich. It takes a rich man to be a wireless fan in England. Every year he goes up into the mountains of Scotland with some fellow fans and there, in the wild places, they put up their outfits and practise sending and receiving and try out new parts and play all the tricks that 200,000 ordinary, every-day American fellows try out every night of their lives, if they want to, in their homes in every part of the United States.

The British navy officials have, until recent years, been very jealous of English ether. Before the war a young man had as much chance to rig up his own wireless outfit for receiving and sending as he would have had to start a new postal system in his community or dig a ditch across a public road.

Laws against the amateur are being loosened in England since the war. So many wireless operators were developed in the army and the navy that, within the past two years, British officials have discovered that they must encourage the amateur if they want to have operators ready for military purposes.

Perhaps some day the British government will be as gentle and encouraging with the wireless amateur as Uncle Sam during the past ten years has been with the amateurs of the United States.

During some long railway journeys in England last year I saw only one antenna on a private house.

ACROSS the British Channel in France the amateur wireless fan, Pierre, must do everything under the bed. Let one of his ether whispers get out into the air, and he'll have a government policeman at his house in short order. The French army owns French ether, and it doesn't allow any loafing or trespassing therein. I traveled from one end of France to the other last year and criss-crossed the country but never once did I see an amateur wireless set. It is

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ERECTING MINIATURE TOWERS OF BABEL

In the country as well as in the city districts the radio amateur is indefatigable in his efforts to develop to the highest efficiency the equipment that comes within his means.

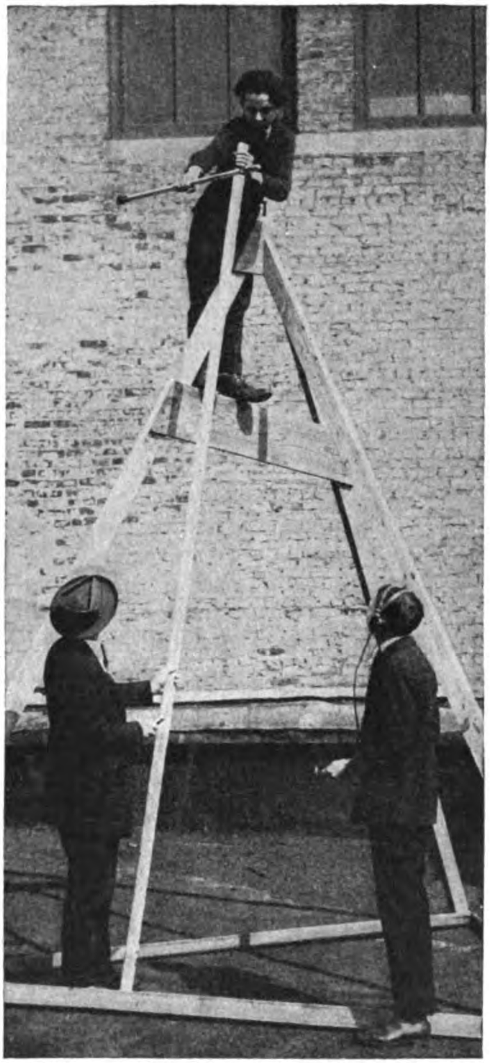
possible that a fan here and there may have put up an antenna, but the minute his wires go up over the family roof-tree his house is under suspicion. French amateurs are allowed to receive the time signals from the Eiffel tower and the weather reports. They're not allowed by law to tune up or down to anything else. They cannot listen to government messages and they are forbidden to listen in on commercial messages. Calls for help at sea are none of their business. It isn't enough that a French amateur is willing to promise the government that he will keep secret all that he hears in the ether. Even in the secrecy of his own room he is supposed by law to tune out of all official or commercial wavelengths.

Whether the French amateurs do this or not no one knows. A copy of a commercial or government message found in the room of a wireless amateur would bring him a fine of $100, or worse.

Some of the rich amateurs of France establish their sets in the mountains down south and experiment at short wavelengths, but they must have government permission to do this and they must take great pains not to interfere with the commercial company or the government. The French deny that Marconi discovered the principles of wireless telegraphy and they are very jealous both of the use of the ether and of their own wireless apparatus.

IN Germany the government owns the ether. An amateur has no more right to trespass therein than he would have to go behind the screen in the post office and help to sort letters or sell postage stamps. I tried to find wireless amateurs in Germany last winter and I discovered not one. It might be possible for an amateur to rig up an apparatus secretly and listen in on Nauen, but your true amateur is not satisfied with playing the sneak and listening without taking an active part in the throbbing of the ether waves.

In little Holland, now and then, you see the rigging of the wireless amateur on private homes. But these are always fine big homes and you realize that here the wireless set is the toy of the rich.



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HE JUST "DECLARED HIMSELF IN"

The ingenious American boy waited neither for permission nor encouragement; he started years ago to work wonders with his home-made radio outfit.

Being near the sea the Dutch wireless amateur may listen in on interesting conversation. By doing this he is not breaking the law of Holland. But let him so much as send out one of his own ripples and the law comes down on him in a hurry—military law that is never very gentle.

All of the laws that have been passed in European countries against the amateur means that very little apparatus is made for the amateur. There are no great factories that are turning out supplies for him. He cannot become a wireless fan overnight by merely stepping into a shop or sending a check to a manufacturer and buying a receiving set. He must either have a set made for him or must collect the parts, as best he can, and make his own set.

In all of Europe cheap sets are as scarce as antennae. And if you think amateur antennae are plentiful, just take a trip through Europe with a friend some time and get him to offer you $10 for every rhinoceros you see if he'll give you $10 for every amateur antenna he sees. You'll win, because you can take him to a zoo in every big town on the Continent, and the chances are he won't be able to find an amateur wireless outfit from Russia to the Mediterranean.

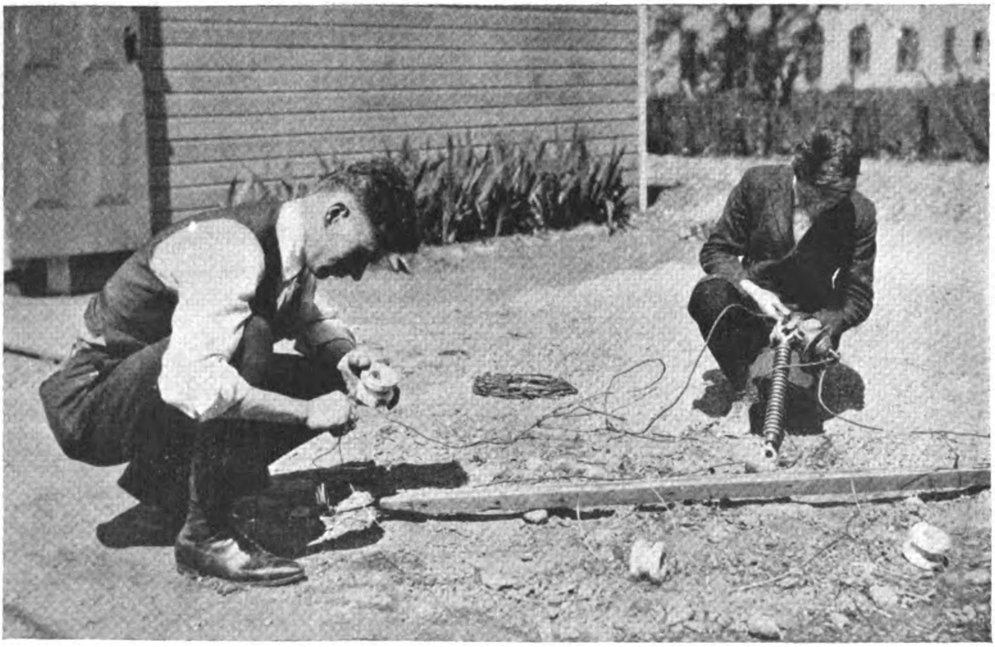
¶ *The United States is the land of the wireless amateur, and it is an important thing for the amateurs of this country to realize this fact.*

What Uncle Sam has gained by not closing the ether to the American boy fifteen years ago can never be measured. Many of the most prominent and progressive wireless engineers of the country to-day began as amateurs less than a generation ago.

The good American fashion in which the American boy "declared himself in" on wireless ought to make us all proud of our country and its methods of government.

Up to the time of this writing, early in April, Uncle Sam has not taken any single action against wireless amateurs that has prevented the spread of amateur interest in wireless.

The American navy has had its corner



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YOU WOULD NEVER SEE A SCENE LIKE THIS IN EUROPE

What Uncle Sam has gained by not closing the ether to the American boy can never be measured. Many of the prominent wireless engineers of the country today began as amateurs less than a generation ago.

Photo by Brown Bros.

NOT ALL OF THE FANS ARE YOUNG MEN

A large proportion of the amateurs in this country are men between fifty and sixty—doctors, lawyers, business men, teachers—who have done much to develop "the radio art."

of the ether, but it has not tried to crowd out the amateur. Indeed, it has been doing much to find a place for him.

The American army has also had plenty of room in the great void. As soon as the war was over all military regulation of the amateur was dropped. Today the army is doing all it can to develop as many amateurs in the United States as possible, and the Amateur Radio Reserve, fathered by the Signal Corps, is the direct growth of that interest.

Commercial companies have, now and then, endeavored to persuade the government to discourage the activities of the amateur but it must be said that, up to this writing, the government and its army and its navy have always been on the side of the amateur.

Because Uncle Sam has been a good Uncle—the best Uncle a wireless amateur ever had—we have scores of thousands of amateurs in the United States today, as compared with almost none in Europe.

Here's hoping Uncle Sam never turns European.

And, for the sake of hundreds of thousands of young men in Europe who do not yet know the thrills and joys of the wireless amateur, here's hoping that European governments turn as kind as Uncle Sam. We Americans want this to be so, for if this comes about, then some day, sure as fate, amateurs will be trading lessons in languages across the Atlantic and Pacific oceans.

Night schoolrooms in France hooked up with night schoolrooms in America—!

Well, it's never safe to let your imagination run loose about wireless.

¶ *How the Radio Is Being Developed by the Police Departments of Our Cities and Towns as Well as by the Department of Justice in Running Down Fugitives, Will Be Told in the June Issue by Fred C. Kelly, formerly of the U. S. Secret Service.*

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Science may yet conclude that Guglielmo Marconi was the first man on this earth to pick up a radio message directed by a superior intelligence from another world.

Are We Getting Radio Signals *from* Another Planet?

If Not, How Can the Recently Recorded Wireless Impulses of Tremendous Power be Explained?

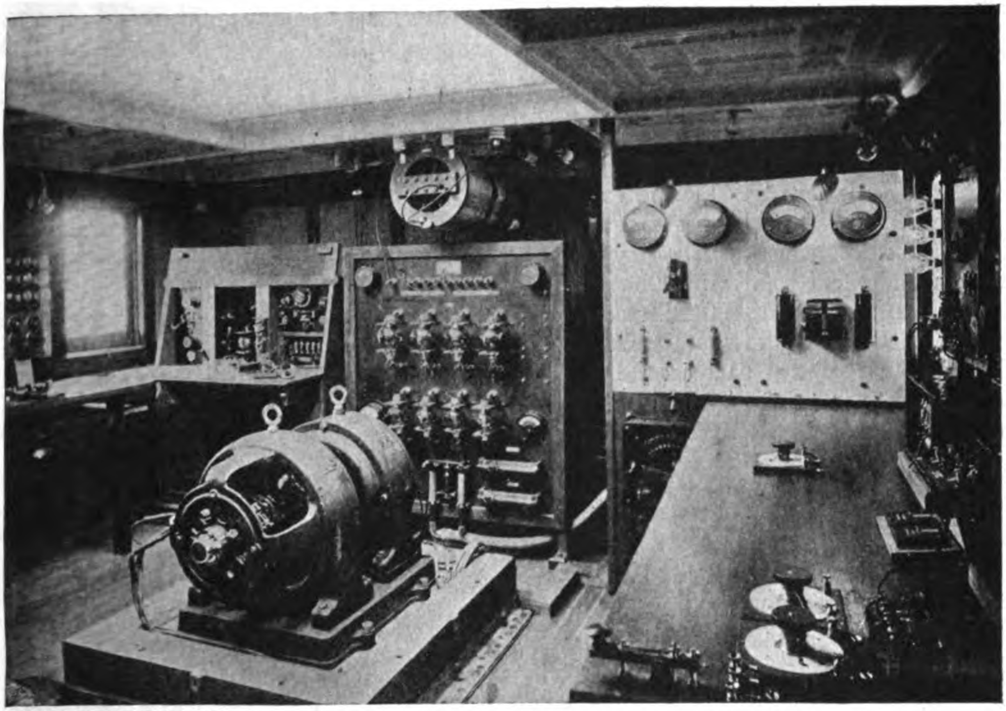
By E. E. FREE, Ph.D.

ARE wireless signals being received on the earth from some other point in space, possibly from the planet Mars? Marconi thinks that they may be; everyone knows of his success nine months ago in picking up impulses of very long wave length, believed not to be of terrestrial origin—impulses which are suggestive, to say the least, of signals sent out from some source and directed by intelligent beings.

This amazing conclusion may yet be demonstrated. That the impulses that Marconi recorded come from some source is, of course, evident. If they do not come from intelligent beings of another planet, what other possible explanation of them can be offered? Are there any "natural causes" by which wireless impulses might be generated somewhere in the universe by processes not involving intention or intelligence on the part of creatures more or less like man?

Yes. A possible explanation of these impulses may be found in what are called sun-spots.

Through an ordinary telescope (the eye being protected, of course, by a dark glass), the sun looks like a glowing disk of fire. Occasionally on this disk may be seen a darker blotch or two, sometimes very small, sometimes large enough to cover a considerable fraction of the sun's apparent diameter. These blotches are sun-spots. Astronomers know that they



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WHERE THE MYSTERIOUS SIGNALS WERE RECEIVED

A close-up of the equipment in the radio laboratory on board the yacht "Electra," on which Marconi recorded radio wavelengths estimated as high as 150,000 meters—about five times greater than those produced by man-made apparatus.

are due to violent disturbances or "storms" in the surface layers of the sun.

The sun is really a great ball of hot and glowing gas. Its surface is literally a sea of fire. Or, more exactly, the clouds which fill the atmosphere of the sun are not water-clouds like those of earthly skies, but clouds of blazing, incandescent gases—clouds so hot as to be altogether beyond terrestrial comparisons. The temperature of the sun's surface is believed to be about 6,000 degrees centigrade—over three times as hot as the inside of a white-hot iron furnace, nearly twice as hot as the hottest thing ever devised by terrestrial physical science, the crater at the end of one of the carbons of an electric arc.

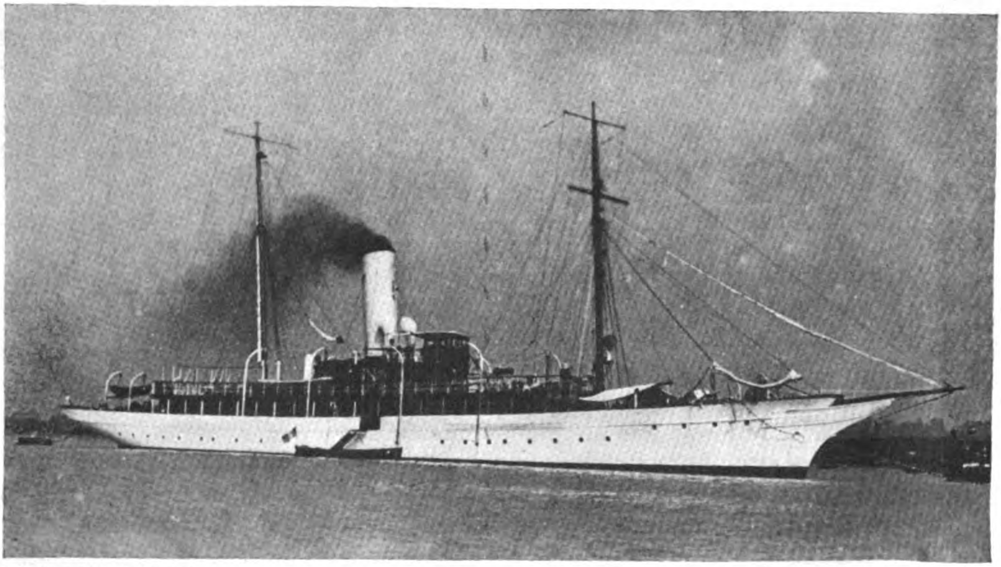
Naturally the clouds of sizzling gas on the sun are in constant motion, boiling up and down, surging back and forth with millions of times the velocity and power of earthly winds or cloud currents. Imagine the sea tossing flame above a burning building and suppose this multiplied perhaps a million million times in intensity and a few more million million millions in size. This is the continual condition of the sun.

But sometimes the boilings and surgings of the solar fire clouds, the intensities of these solar storms, are especially violent; it is then that we get sun-spots. A tremendous whirlwind, perhaps, tears apart the glowing cloud envelope of the sun and gives us a glimpse of lower strata not quite so transcendentally hot, or, more probably, the solar storm drives upward from the sun's surface a great ascending column of white-hot gas. During the eclipses of the sun ascending fire columns like this become visible and have been seen to rise as much as 300,000 miles above the surface, more than one-third the diameter of the sun. Such a rising stream of gas cools rapidly. As it cools it becomes less incandescent, darker. At the same time it hides, to some extent, the more brightly glowing surface underneath. This makes a sun-spot, a visibly darker speck on the glowing disk of the sun.

It is difficult for earth men to conceive the tremendous scale of these sun-spots and the solar storms which they cause. The incandescent solar winds have been seen to blow as fast as 600 miles an hour. The diameter of a sun-spot, probably itself only the central part of the storm, may be well over 100,000 miles, more than four times the distance around the earth. Beside these solar cataclysms the most destructive earthly tornado, the most violent thunderstorms, are gentle zephyrs in the proverbial tea cup.

ALL this has a direct bearing upon wireless for this reason: the sun-spot storms are known to be electrical. Probably they are electrical in origin, certainly so in many accompanying occurrences. And if they are electrical at all they are like other electrical disturbances in having wireless effects, in providing wireless waves as any electric spark would do. These wireless waves go out everywhere through space just as do the waves from the antennæ of a terrestrial sending station. A solar storm furnishes, indeed, the most powerful known sending station.

The same waves which carry the nightly concert to your household radiophone also bring to you, whether or not you recognize it, news of the latest electric storm on the sun. Whenever there is a great electric storm on the sun, or better still, when there is a more or less extended period of solar storminess, this storm is evidenced to our telescopic eye by the occurrence of a large sun-spot or of many sun-spots. From these sun-spot storms as centers there rush out into space great streams of electric energy—two kinds of energy; *first,* the wireless waves of which I have already spoken, and, *second,* streams of electricity itself, of electrons. These latter are not unlike the familiar corona discharges from high-voltage wires. Both the solar wireless waves and the electron streams have important terrestrial effects; effects, indeed,



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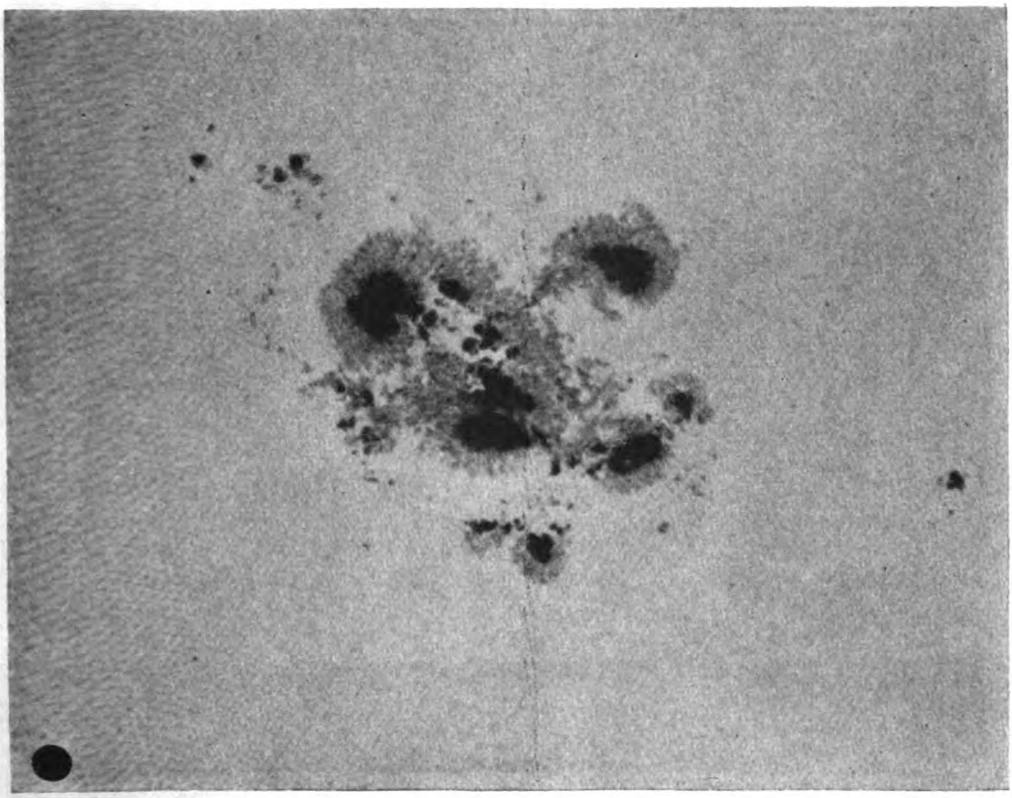
To get away as completely as possible from interruption, Marconi conducts his research work on his private yacht "Electra," which spends much of the time cruising on the Mediterranean.



THESE SUN-SPOTS TRANSMIT RADIO IMPULSES OF GREAT FORCE

The black disc in the lower left corner represents the earth. Compare it in size with the "spots" on the sun, photographed at Mount Wilson Observatory, August 8, 1917—*the very disturbances which the necromancers stated augured America's participation in the World War.*

of everyday importance to man, not merely of scientific interest. For instance, the solar electric energy—we do not know whether it is the wireless fraction or the electron fraction—is perhaps the most important single influence in controlling the day-by-day variations of the weather.

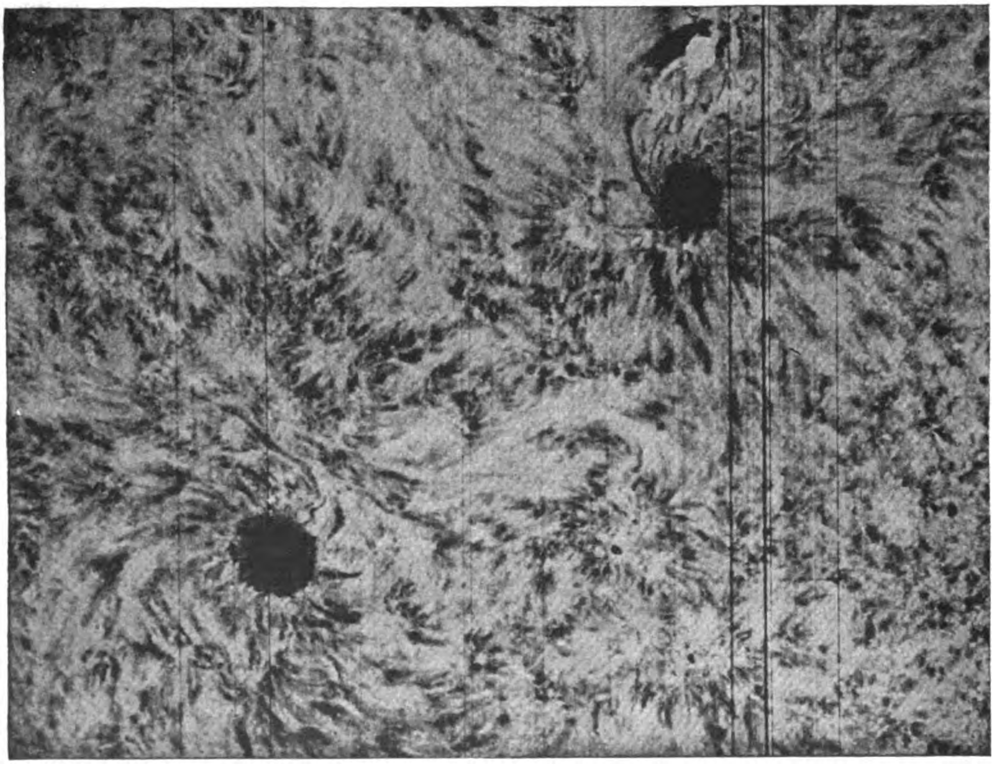
A storm on the sun, although it occurs ninety millions of miles away, has more effect on the daily life of the New Yorker than a thunderstorm in San Francisco. As a matter of fact, the California storm was the offspring of the solar one, that storms on the sun control the occurrence of storms on earth. There can be no doubt at all that solar storms influence greatly the number, path and intensity of the storms on earth.

The day-by-day variations of terrestrial weather, daily as distinguished from the seasonal variations of winter, spring, summer and fall, are the result, in the main, of two causes: variations in the amount of heat and light received from the sun; and the electrical, or perhaps electro-magnetic conditions of the earth and its atmosphere. Solar storms do not affect greatly, or immediately the amount of heat or light which the sun sends out, but they do affect, very greatly indeed, the electro-magnetic condition of the earth.

It has been shown, for instance, by numerous comparisons of the actual records, that there is a direct and important connection between the number and size of sun-spots and the occurrence on earth of what are called "magnetic storms," that is, of periods of rapid fluctuation in the direction and dip of the compass needle, in the strength of the earth's magnetic field, and in other electric and magnetic phenomena. Wireless operators know to their sorrow the effect of these magnetic storms on ease of communication, on the prevalence of "static." There are parallel influences on the occurrence of the aurora borealis, the northern lights. Science traces all of these things to the wireless (or perhaps the electronic) effects of the solar storms.

How this happens, indeed how it literally must happen, will be clear at once to any student of wireless. Any electric disturbance, a spark, a condenser discharge, a current in a wire, sets up a wireless wave. That terrestrial thunderstorms do so is familiar knowledge. And the solar storms, being electric disturbances of tremendously greater violence, have correspondingly powerful wireless impulses, impulses powerful enough to retain across ninety million miles of space the strength to alter seriously the electro-magnetic condition of the earth.

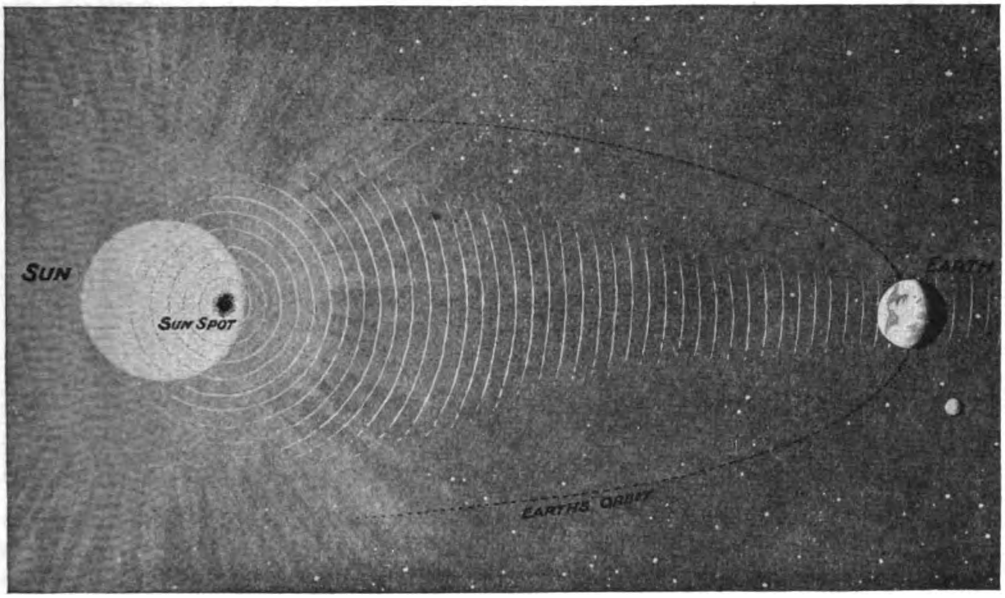
The more usual, every-day aspects of terrestrial weather—the rainfall, the air temperature, the frequency and violence of storms—are believed to be affected by solar wireless indirectly, by way of the more direct effects on the earth's magnetism and electricity. The solar wireless waves alter these electro-magnetic conditions. These conditions alter the weather. Discussion of exactly how these successive effects are believed to succeed and cause one another would lead us far afield into a part of meteorological science which is still imperfectly understood. It is here that wireless experts can and will help the meteorologists, and when they



From a spectograph taken at Mount Wilson Observatory, California

DO SUCH SOLAR DISTURBANCES EXPLAIN THE RADIO "SIGNALS?"

From these inconceivably great whirlwinds of flame that sometimes shoot up 300,000 miles into space, the earth receives electrical impulses comparable to those from a radio sending station.



HOW RADIO WAVES MAY REACH THE EARTH

That there is a direct and important connection between the size and number of sun-spots and the "magnetic storms" on earth can no longer be questioned.

have done so there will be, doubtless, a lot of interesting things to say.

For the present we have the bare facts. Connections have been traced between solar storms and terrestrial storms. One link of these connections is known; namely, the occurrence of magnetic disturbances on (or in) the earth. The other links, still missing, offer to the wireless enthusiast one of his most alluring problems.

There are, of course, a thousand speculations which one might pursue. What are probably the wave lengths of this solar wireless? Are they, like Mr. Marconi's signals, so long as to remain entirely unperceived by the usual standard wireless apparatus?

Does the wave approach a pure tone of single wave length or is it (which is more probable) an inextricable mixture of thousands of irregular waves?

What are its relations to the shorter waves, also electro-magnetic, or ordinary light?

How is it involved with the solar streams of actual electricity, of electrons?

Or, to shift the ground of questioning earthward, what terrestrial effects still entirely unpercieved by man may be traced some day to solar wireless?

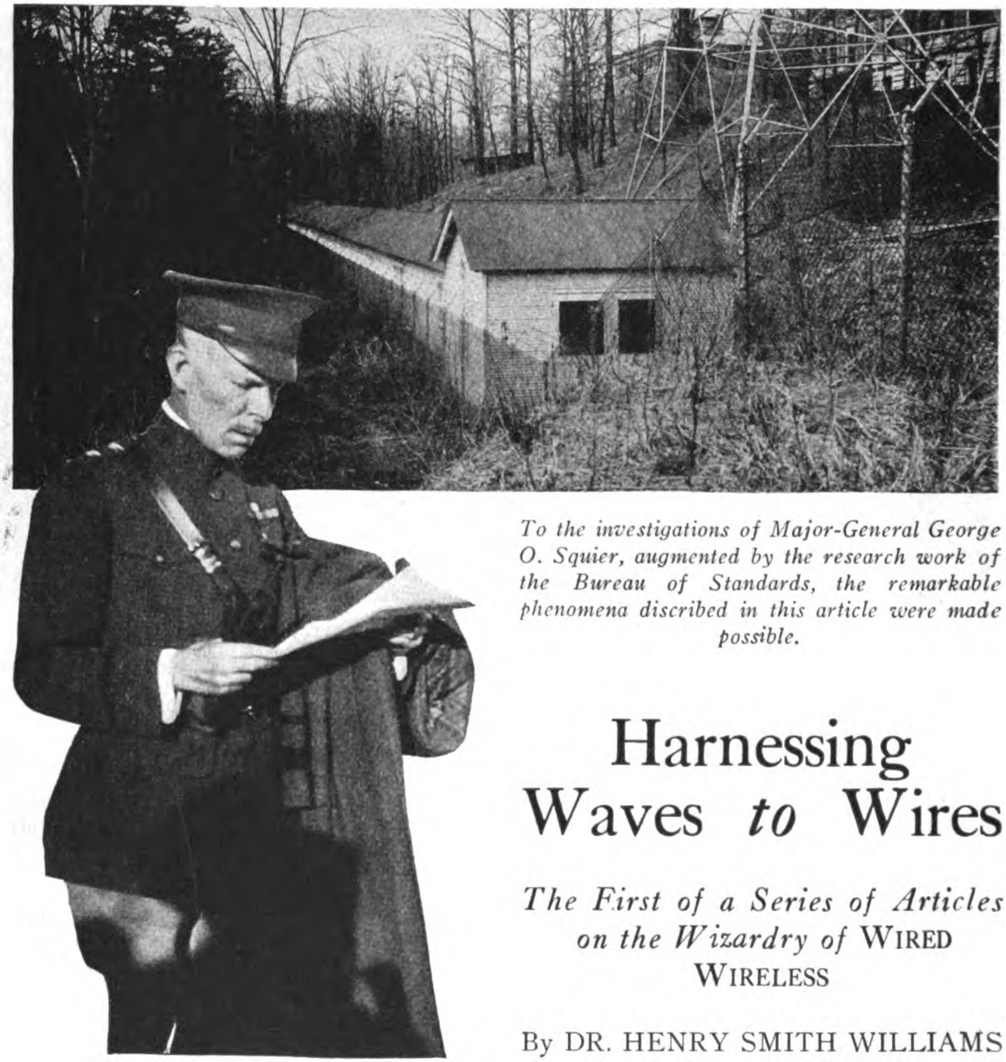
All this is merely one of the possible explanations of the wireless impulses recorded by Marconi. These impulses might be coming from some other planet than the sun. There are other planets in our own family.

Mr. Marconi's signals may be, in fact, a product of Martian intelligence. Or they may be news of natural changes in the rings of Saturn, word of cataclysms in the solar system of some inconceivably distant sun.

We may yet live to read in our newspapers such headlines as this:

> "Wireless seismograph of the National Observatory records great earthquake on Sirius. Other stars believed to be affected. Expected changes in the satellites of Jupiter will probably be delayed."

The daily news is already international. Is it to become interstellar?



To the investigations of Major-General George O. Squier, augmented by the research work of the Bureau of Standards, the remarkable phenomena discribed in this article were made possible.

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Harnessing Waves *to* Wires

The First of a Series of Articles on the Wizardry of WIRED WIRELESS

By DR. HENRY SMITH WILLIAMS

IF the textile workers of America had been able to braid silk a little faster (or, to be accurate, a good deal faster), there would probably be no such thing as "wired wireless" known to radio science to-day.

Of course you do not see the connection unless you happen to know the story. The application is simple, however; Major-General George O. Squier, known to everyone as the originator of the wired wireless method, explained it personally at the outset of the paper in which he made popular announcement of his discovery. This is how it happened:

The "key problem" in the procurement of essential Signal Corps supplies in the United States during the World War was the production of the necessary braiding machines for finishing insulated wire. The wire itself could be obtained; rubber insulation could be obtained; and there was no dearth of cotton thread for making the braid—but machinery for braiding the thread was inadequate, and could not be rapidly supplied.

All the braiding machines in the United

States in September, 1918, could produce the braided covering for only eight hundred miles of twisted pair insulated wire a month—and the American forces alone required forty thousand miles a month! And as if this was not bad enough, the allied council decided on October 1st, 1918, that it would be necessary for the United States to furnish all of this type of wire used by the allied armies in the field, beginning March 1st, 1919. The estimated minimum requirement was 100,000 miles a month, or more than twelve times the capacity output of all the American machinery in existence.

Confronted with this situation, the United States Signal Corps, with General Squier at its head, not unnaturally realized the desirability of finding a substitute for braided cotton thread.

The Signal Corps found it. Indeed, it found something not merely "just as good," but in many respects vastly better. Confronted with the shortage of braiding machines, General Squier said, in effect: "Let us try electron tubes instead." Asked to supply 100,000 miles of braided cotton a month, he said: "I will give you an unlimited quantity of electromagnetic waves instead."

Succinctly stated, what General Squier did was to run a bare wire of phosphor bronze (number 18, such as is used for Signal Corps field antennae) across the Washington channel of the Potomac River from the Army War College to the opposite shore in Potomac Park, letting it sink to the bottom and lie there absolutely unprotected. Not only was the wire not insulated, but pains had been taken to clean it entirely and free it from any grease or other material that could in the least protect it. A standard Signal Corps radio telephone and telegraph set was directly connected to each end of the wire; one set served as transmitter and the other as receiver. At the receiving end, the bare wire was directly connected to the grid terminal of an electron tube in the receiving set and the usual ground connection was left open. Tuning the wire to a frequency of about 600,000 cycles a second, excellent telegraphy and telephony were attained.

"This experiment," declared General Squier, "demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water, and the use of an electron tube as a potentially operated device on open wire for the reception of signals."

That statement shows the characteristic modesty of the true scientist. For the simple experiment had really resulted in a fundamental discovery, foreshadowing the opening up of an entirely new department of radio science of almost inexhaustible possibilities.

If, one of these days, you are able, sitting in your New York office, to take your telephone receiver off the hook and have a chat with a friend in London, it will be because General Squier was led (owing to the shortage of braiding machines) to find out whether he might not send a message along a bare wire under the Potomac.

THERE are many interesting things to be told about General Squier's further experiments, which include successful tests of the bare wire as a carrier of messages when laid along the moist earth, and even buried under the soil; but before we come to these, let us consider the question as to how and why the electromagnetic waves follow the wire and are thus led to a definite goal, instead of radiating out into space and becoming rapidly attenuated as in ordinary radio transmission.

This question, however, can be answered only provisionally. We have to do with an extremely puzzling phenomenon. Only a very bold or reckless theorizer would have predicted, with any measure of confidence, the results which were actually attained. Ninety-nine radio operators in a hundred would have dismissed the notion that a wireless message could be sent along a wire as absurd. The very phrasing seems self-contradictory. It is more than likely that General

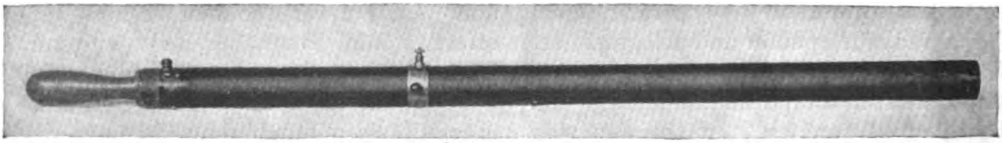
Squier himself was not over-confident about the success of his experiment. But his imagination conceived the thing as possible; and presently his ears told him that the possibility had become a reality. "Wired wireless" was an accomplished fact, whether or not a theory could be found to make it plausible.

The discoverer himself was content for the moment to go on with his experiments, avowing no theory by way of explanation. Doubtless that was the part of wisdom. Certainly it is better not to hamper a practical discovery by harnessing it too closely with theory at the outset. Nevertheless, no one can thoughtfully consider the phenomenon without at least attempting to form a mental picture of things that are happening along the course of the strand of copper wire that is so magically holding the electromagnetic waves in leash.

Of course it is not to be supposed that the electromagnetic waves travel in or even on the wire. By definition, these waves are undulations in the ether of space, which is supposed to be the universal medium, occupying the interstices between the electrons that are conceived as the ultimate particle of matter. According to one theory, the electron itself is only a whirl in the ether. In any event, the ether appears to ignore the very existence of matter, passing between the molecules of the most solid substance more freely than water passes through a sieve, inasmuch as there is no friction. The electromagnetic waves with which ordinary radio deals are not altogether unaffected by material substances, but to an amazing degree they appear to ignore obstructions. As an illustration, we have just seen that the electromagnetic waves of General Squier's experiment followed the course of the wire laid along the bottom of the Potomac, apparently ignoring the presence of the water. Yet they obviously did not ignore the wire altogether—otherwise they would not have followed it.

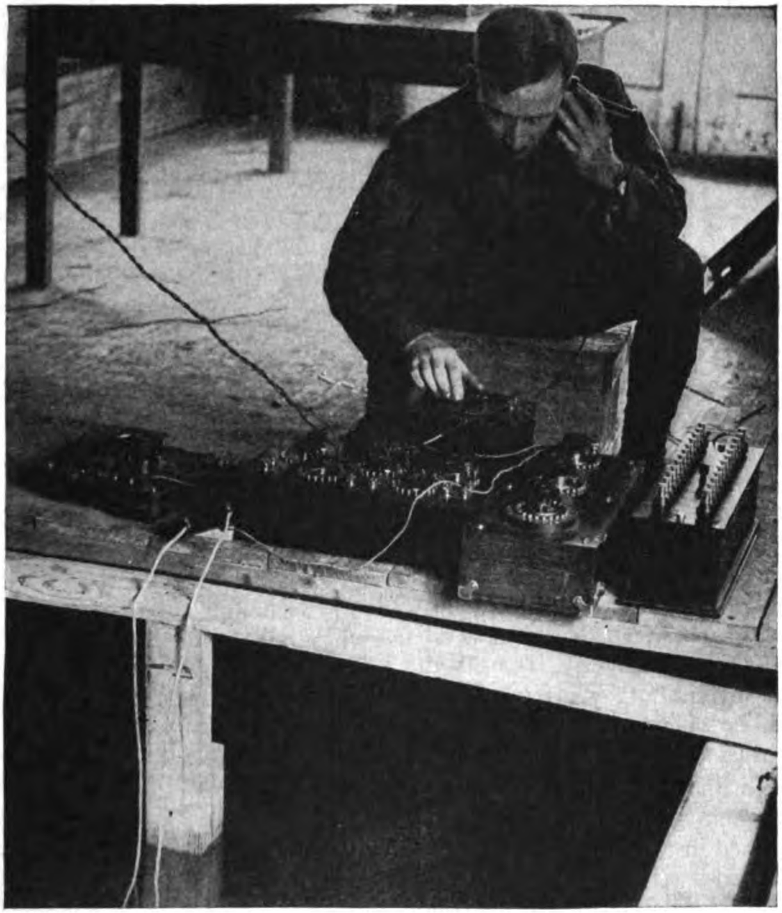
It was not the wire itself, in all probability, that enchained the electromagnetic waves, but the electric field about the wire. An electric field, according to accredited theory is merely the condition (of "strain" or what you will) that exists in the ether surrounding an electron or group of electrons. When electrons are in transitional motion, their transit is manifested in what we term a current of electricity, and the motion of the electric field about them establishes a condition that we term magnetism. The moving electric field is parent to the electromagnetic wave; so perhaps it is not strange that an electromagnetic wave in being should have affinity for the electric field surrounding a copper wire that chances to lead out from the source of its origin.

At first thought it seems odd that the electromagnetic wave should follow a bend in the wire; but we must reflect that the electromagnetic waves of ordinary radio do not travel in a straight line, but follow the curve of the earth's surface. Possibly the electro-static conditions of the lower atmosphere have to do with the course of ordinary radio waves somewhat as the electric field about the wire has to do with the directed waves of General Squier's experiment,—the earth's surface itself representing, in this view, a magni-



A DIVINING ROD FOR WIRELESS WAVES

This remarkable miniature coil antenna—a trifle larger than an ordinary walking stick—collects radio impulses when it is turned and pointed in the direction whence the impulses emanate.



MEASURING THE HIGH FREQUENCY RESISTANCE OF WIRE UNDER WATER

An experimenter at work on the impedance bridge in the Signal Corps laboratory at the Bureau of Standards in Washington.

fied wire-surface. The familiar fact that radio messages are rapidly dissipated in the daytime, when the upper atmosphere is believed to be charged with electrons from the sun, possibly gives support to the analogy.

All this is mere theory, however, which the reader may find more or less satisfactory according to the bent of his mind; but which can neither add to nor detract from the force of observed facts, to which we now return. The traditional apple falling from the tree on the pate of Sir Isaac Newton bruised the philosopher neither more nor less because of the theory of universal gravitation.

THE experiment of sending messages along the bare wire under the Potomac having thus succeeded beyond all reasonable expectation, a question naturally rose as to whether the experimenters might have drawn a false inference from their observations. Might it not be that the portions of wire out of water at either terminal had acted as antennae, and that the electromagnetic waves had passed directly through the air, as in ordinary radio transmission, or along the surface of the water?

To answer that question, the simple procedure was adopted of cutting off the main portion of the wire, leaving only the short aerial portion at sending and receiving stations, and a few feet under water. But now messages were no longer transmitted; and this negative result was very properly interpreted as demonstrating that the messages previously sent and received had in reality been directed along the wire.

Sundry other confirmatory experiments having been made with a submerged wire, attention was directed to the possibility of conveying a directed message along a wire lying on the ground. A bare No. 16 wire was laid on the surface of the earth connecting the main laboratory of the Signal Corps and a small field station one and three-quarter miles distant. The radio telephone instruments used were standard sets utilizing an oscillating transmitter of the electron tube type. The transmitting current was about one hundred milliamperes, at any of the wavelengths available with these sets, ranging from about 200 to 550 meters. It was found that good telephone communication could be made with this equipment.

As the next important step in the series of experiments, the bare transmitting wire was buried in the earth to a depth of about eight inches. The bare No. 16 wire was laid in a plowed furrow and a second furrow was plowed alongside, completely covering the wire. The soil was moist, sandy loam, only a few feet above tide water.

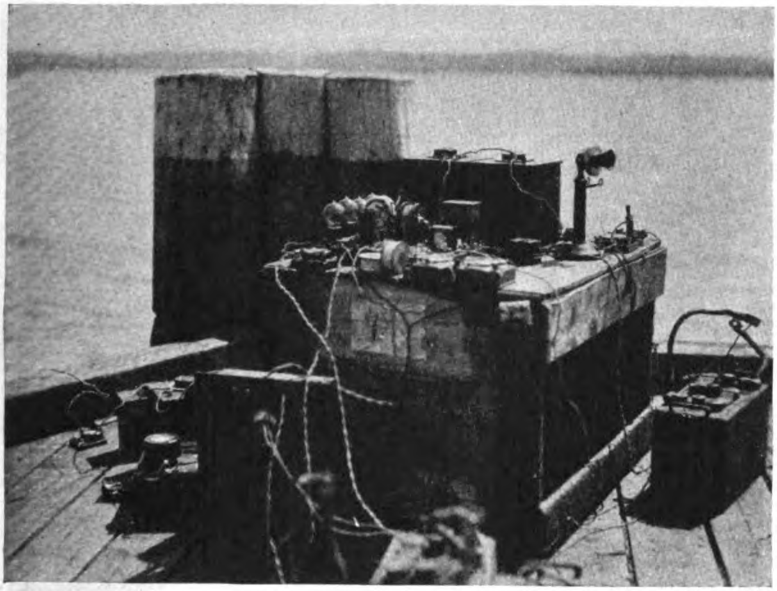
The wire thus buried conveyed the electromagnetic current as before, and satisfactory communication was established for the distance of about a mile.

To make the experiment more definitive, tests were made with the buried wire not laid in a straight line, but turning at various angles. Were the wire serving only as an ordinary antenna, it was reasoned, signals would be detected in the direction of a prolongation of a straight portion of wire; but in reality the test showed that signals could be detected best in close proximity to the wire itself in all its parts, proving that the electromagnetic waves turned the corners in order to follow the wire.

Although the soil did not prevent the passage of the message-carrying waves, it did exercise a curious influence, screening them and in effect preventing their escape from the region of the wire. Proof of this was found by moving an exploring coil along the line of the buried wire. The detecting instrument, held just above the surface, failed to reveal a signal; but when a short length of the wire was exposed by removing the earth, signals were at once appreciable, and these disappeared when the earth was put back over the wire.

General Squier comments on the importance of this phenomenon from the standpoint of military usage. It is obvious that with a buried wire radio messages could be sent in secrecy, a desideratum well nigh impossible of attainment with aerial messages.

THE successful termination of the experiments above described may be said to have established the principle of "wired wireless" beyond controversy. The importance of the discovery was so patent as to excite universal interest. Although the original tests had been made to meet war-time needs, it was clear that the new method would have abundant peace-time applications as well. The possibility of sending several messages along the same wire simultaneously at once suggested itself; and it was believed, with reason, that adaptation of the method will make feasible the transmission of messages to and from moving trains. Let it here suffice to note, however, that General Squier, whose earlier experiments in multiplex telegraphy are well known, stated in his early report that the applicability of the new method to multiplexing was self-evident. It is obvious to anyone familiar with the general principles of radio transmission that it should be possible, by using different wavelengths, to send several messages simultaneously in either direction along a single wire, each message in-



WHERE THE EARLY EXPERIMENTS WERE MADE

The original transmitter used in the submarine wireless experiments between Fort Hunt, Va., and Fort Washington, Md. The bare wire over which the signals were sent is shown going over the edge of the dock at the left.

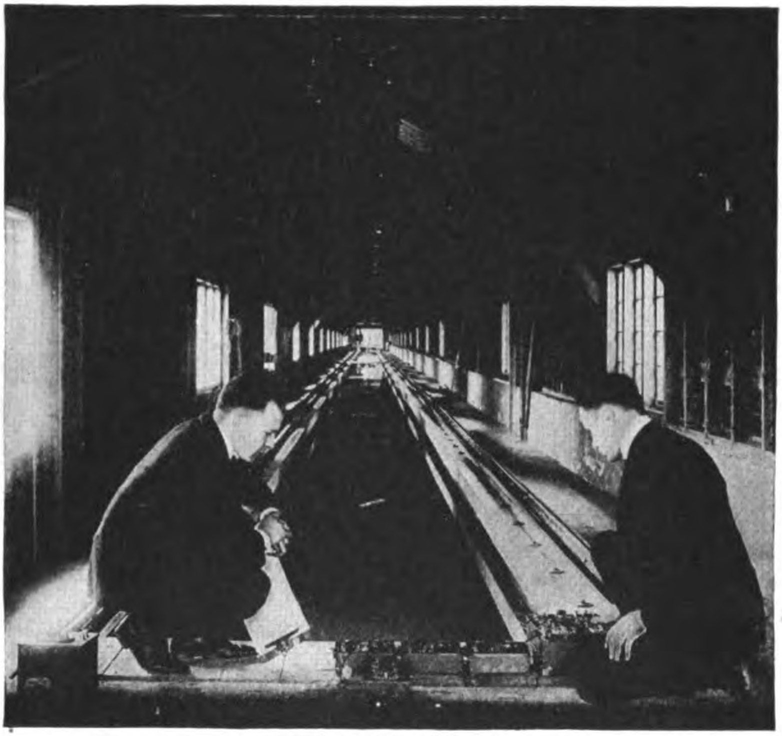
distinguishable except to the particular instrument tuned to receive it.

Practical experiment was presently to demonstrate the validity of this assumption. In the meantime experiments designed to throw light on less patent features of the new method were undertaken, particularly in the Signal Corps research laboratory at the Bureau of Standards. One object was to determine the electrical constants of bare wire submerged in water when subjected to high frequency currents.

At the Bureau of Standards a tank was available 125 meters long, 2 meters deep, and 2 meters wide. Two wires placed in the tank served as a to-and-fro conductor, constituting a complete transmission line immersed in water. Using an electron tube oscillator as transmitter, measurements were made to determine the apparent impedance of the system with the remote end short-circuited and also open-circuited. Even at the preliminary stages, the observations as to capacity and leakance of the wire were found highly interesting.

"It was seen," says General Squier, "that at low frequencies the capacity is extremely large, about 1,200 microfarads a kilometer, the equivalent of an entire Atlantic cable, but the capacity diminishes very rapidly as the frequency is increased, and at a frequency of about 40,000 cycles a second, it practically vanishes. The leakage increases with the frequency up to about 5,000, and then begins to decrease slowly as the frequency is increased. The results were surprising, particularly the high capacity values at the low frequencies. The experiments apparently show that frequency of the current used has a marked influence on the behavior of water as a medium, and is entirely different from what it would be for direct or low frequency current.

TESTS of this character, while of great theoretical importance (and that means always, potentially, of practical importance), have not the popular interest that attaches to the observations that were made by General Squier and his associates at an early stage of the investi-



WILL THE WAR OF THE FUTURE BE FOUGHT IN SUCH LABORATORIES?

In this tank, 125 meters long, the radio experts of the United States government are carrying on their research work that has led to important changes in communication systems.

gation with the aid of resonance wave coils of various dimensions. The use of the coil was originally resorted to in order to secure high potential points at the receiving end of the line without losing the advantage of tuning, the circuit being open, and the grid directly connected to the line. Adjustment was obtained either by moving along the coil the end of the wire connecting the grid, or by sliding along the coil a narrow metal ring connected to the grid, this constituting a capacity coupling between the grid terminal and the coil. Coils were made up of wavelengths ranging from 250 meters to 1800 meters.

One such coil, for example, was about four and a half inches (11.5 centimeters) in diameter and about twenty-three inches (58 centimeters) in length, with thirty-four turns of the wire per centimeter, and gave a fundamental wavelength of 1700 meters.

This little instrument proved a veritable divining rod. Connected to an antenna or a bare wire in water or earth, as in General Squier's experiment, it can not only be used for tuning, but at the same time wave development on the coil permits a test of the highest potential point, or point of greatest sensitiveness. More than that, the resonance wave-coil can be substituted for the ordinary antenna, itself constituting a complete antenna system. The coil may be grounded at one end or it may be entirely free. In either case it may be utilized to receive radio signals.

"It may be noted," says General Squier, "that in an antenna of this kind all the electrical constants, inductions, capacity and resistance and the electro-motive force induced in it by the incoming signals are of a distributive character, which makes it in a sense an ideal wave-conductor."

Even that does not tell the entire story of the little resonance coil. The discovery was presently made that it possesses also remarkable directive properties. If the coil is turned about, so that its position in relation to the direction of the electromagnetic waves of ordinary radio is modified, there is a constant change in the voltage and current distribution on the coil, and a corresponding shift in the position of the point of maximum potential. If the coil is held at right angles to the direction of the transmitting station from which the electromagnetic waves are coming, these waves beat evenly against it, as will be obvious, and so produce a condition of uniformly distributed electrical constants. There is a point of maximum potential, varying somewhat with the length of the coil, frequency, and terminal conditions. This maximum may be determined in moving the terminal of the grid of an electron tube along the coil. In practise a narrow metal ring that slides freely along the coil is used. But if now the coil is turned to point more or less in the direction of the transmitting station, so that the electromagnetic waves come against it slantwise, the point of maximum potential shifts, owing to the difference in time at which the waves strike the oblique surface.

Here, then, is a direction-finder comparable to the familiar looped antenna which can be so turned as to reveal the plane in which the electromagnetic waves are moving. But the resonance coil goes beyond this, for it was found that when it is moved about until its longitudinal axis is parallel to the direction of the electromagnetic waves (in other words, until it is pointed toward the transmitting station from which the waves emanate), the potential maximum loop, which has shiftel along the shaft of the instrument, is duplicated by another loop of substantially the same amplitude at the opposite end of the coil. If now the pointing instrument is moved about a little, so that its axis is slightly out of parallel with the waves, it is observed that the potential loop at one end has greater amplitude, and that this is the end pointing toward the transmitting station—the north of the compass needle, so to speak.

Evidently, then, manipulation of the little wire-wound divining rod, held in the hand and tested with a sliding ring connected with the receiving grid, makes it possible to determine the direction of the transmitting station from which the signals proceed—a matter of tremendous significance as no one needs to be told. A looped antenna used, let us say, in Baltimore does not tell whether the message comes from Philadelphia or from Washington. But the magic coil gives the answer.

IN THE NEXT NUMBER—JUNE

HENRY SMITH WILLIAMS, *M.D., LL.D., who is writing this series of articles, is not only a distinguished scientist who has made valuable contributions to medicine on his own account, but he is also one of our foremost living writers, with over forty volumes on scientific subjects to his credit. In the* JUNE *issue he will describe the latest progress that has been made in directing electromagnetic waves of radio frequency along naked wires—an amazing story of which the general public knows but little.*

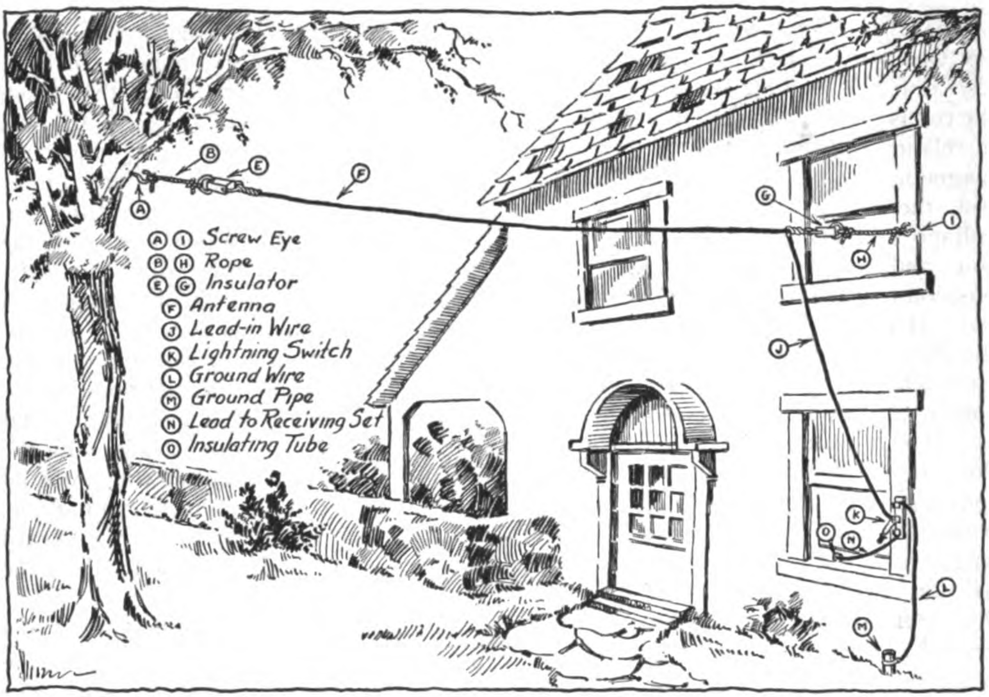


FIGURE 1; *A simple arrangement of stringing the antenna between a house and tree.*

How *to* Make *and* Install Your Own Receiving Set

If You Are Handy With Tools You Can Follow These Directions at a Cost of Between $11.00 *and* $15.00

By WATSON DAVIS

IF you are handy with tools, you may make your own radio receiving set that will be quite good enough to admit you into the vast throng of listeners who are enjoying the musical programs that now fill the ether practically every night. Uncle Sam, as evidence of his helpful interest in his enterprising young nephew, the radio amateur, has carefully worked out a list of detailed instructions that tell him just how to make such a set —at a cost ranging from $11.00 to $15.00.

The problem of working out a practical set of instructions for making this home-made receiving set was delegated to the Bureau of Standards at Washington. This set will enable one to hear the messages sent out from medium-power transmitting stations within an area about the size of a large city, or to hear high-power stations within fifty miles—providing those stations use wavelengths between 600 and 200 meters; that is, wave frequencies between 500 and 1500 kilocycles a second.

Here are the directions:

The Five Parts of a Receiving Station

There are five essential parts of the set: the antenna, the lightning switch, ground connections, the receiving set and the phone. The received signals come into the set through the antenna and ground connection. In the receiving set these signals are converted into an electric current which produces the sound in the phone. The phone is either one or a pair of telephone receivers, worn on the head of the listener. The purpose of the lightning switch is to protect the receiving set from damage by lightning. It is used to connect the antenna directly to the ground when the receiving station is not being used. When the antenna and the connection to the ground are properly made and the lightning switch is closed, an antenna acts as a lightning rod and is a protection rather than a source of danger to the building. The principal part of the station is the receiving set. In the set described herein it is subdivided into two parts, the "tuner" and the "detector", and in more complicated sets still other elements are added.

What the "Antenna" and "Ground" Is

The antenna is simply a wire suspended between two elevated points. Wherever there are two buildings, or a house and a tree, or two trees with one of them very close to the house, it relieves one of the need of erecting one or both antenna supports. The antenna should not be less than thirty feet above the ground and its length should be about 75 feet, as shown in Fig. 1. While this illustration indicates a horizontal antenna, it is not important that it be strictly horizontal; it is in fact desirable to have the far end as high as possible. The "lead-in" wire or drop-wire from the antenna itself should run as directly as possible to the lightning switch. If the position of the adjoining buildings or trees is such that the distance between them is greater than about 85 feet, the antenna may still be held to a 75-foot distance between the insulators by increasing the length of the piece of rope, B, to which the far end of the antenna is attached. The rope, H, tieing the antennae insulator to the house should not be lengthened to overcome this difficulty, because by so doing the antenna "lead-in" or drop wire, J, would be lengthened.

The Parts of the Antenna

A and I are screw eyes sufficiently strong to anchor the antenna at the ends.

B and H are pieces of rope 3-8 or 1-2 inch in diameter, just long enough to allow the antenna to swing clear of the two supports.

E and G are two insulators which may be constructed of any dry hard wood of sufficient strength to withstand the strain of the antenna; blocks about 1 1-2x2x10 inches will serve. The holes should be drilled (as shown in Fig. 1) sufficiently far from the ends to give proper strength. If wood is used, the insulators should be boiled in paraffin for about one hour. If porcelain wiring cleats are available they may be substituted instead of the wood insulators. If any unglazed porcelain is used as insulators, it should be boiled in paraffin the same as the wood. Regular antenna insulators are advertised on the market, but the two improvised types just mentioned will be satisfactory for an amateur receiving antenna.

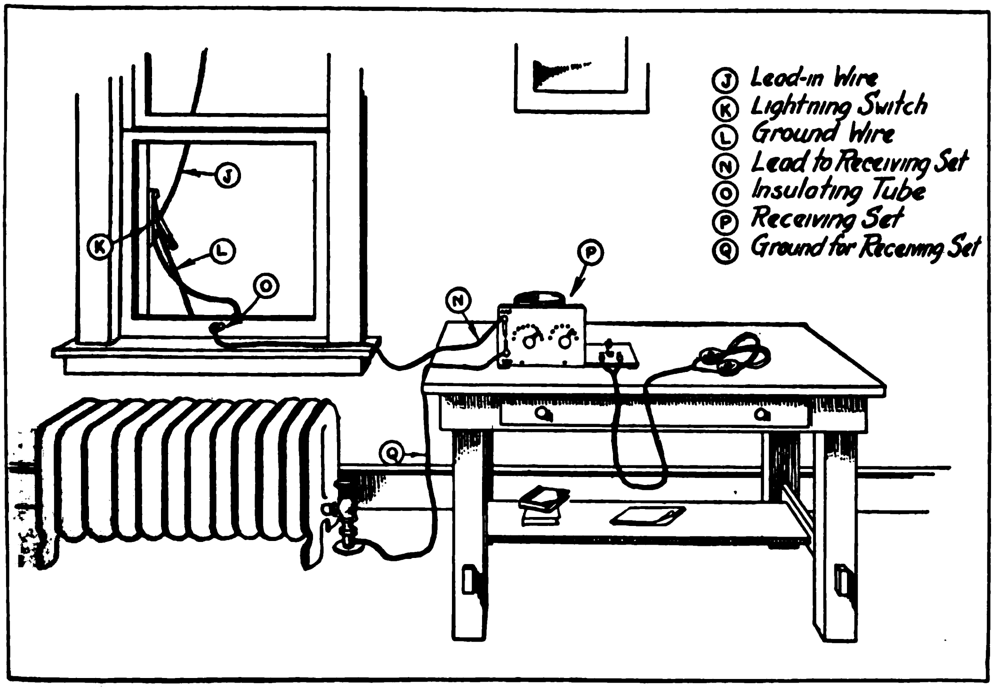


FIGURE 2; *How the lead in wire is brought through the window and attached to the set. Note the ground connection on the radiator.*

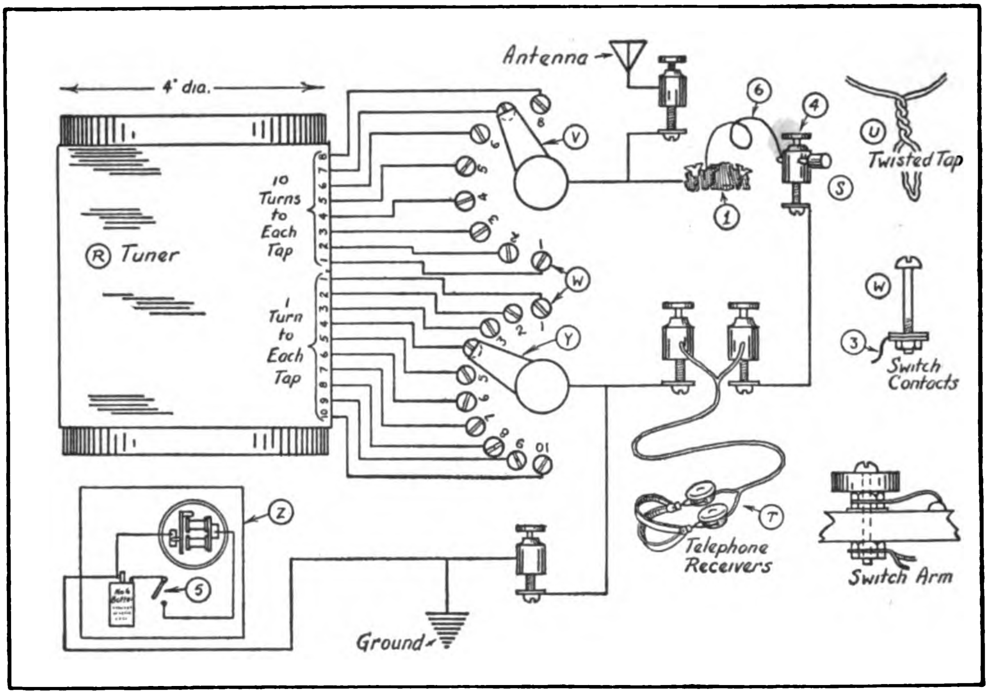


FIGURE 3; *How to connect the instruments. (The buzzer test is shown in the lower left corner.)*

F is the antenna about 75 feet between the insulators E and G. The wire may be No. 14 or 16 copper wire either bare or insulated. The end of the antenna farthest from the receiving set may be secured to the insulator, E, by any satisfactory method, but be careful not to kink the wire. Draw the other end of the antenna wire through the other insulator, G, to a point where the two insulators are separated by about 75 feet, twist the insulator, G, so as to form an anchor as shown in Fig. 1. The remainder of the antenna wire, J, which now constitutes the lead-in or drop-wire, should be just long enough to reach the lightning switch.

K is the lightning switch. For the purpose of a small antenna this switch may be the ordinary porcelain-base, 30 ampere, single pole double-throw battery switch. These switches, as ordinarily available, have a porcelain base about 1 by 4 inches. The lead-in wire, J, is attached to this switch at the middle point. The switch blade should always be thrown to the ground clip when the receiving set is not actually being used and to the receiver clip when it is desired to receive signals.

L is the ground wire for the lightning switch; it may be a piece of the same size wire as used in the antenna, of sufficient length to reach from the ground clip of the lightning switch, K, to the clamp on the ground rod, M.

M is a piece of iron pipe or rod driven 3 to 6 feet into the ground, preferably where the ground is moist, and extending a sufficient distance above the ground in order that the ground clamp may be fastened to it. Scrape the rust or paint from the pipe before driving in the ground.

N is a wire leading from the receiver clip of the lightning switch through the porcelain tube, O, to the receiving set binding post marked "antenna".

O is a porcelain tube of sufficient length to reach through the window casing or wall. This tube should be mounted in the casing or wall so that it slopes down toward the outside of the building. This is done to keep the rain from following the tube through the wall to the interior.

The Parts of the Receiving Set

P is the receiving set, which is described in detail.

N is the wire leading from the antenna binding post of the receiving set through the porcelain tube to the upper clip of the lightning switch. This wire, as well as the wire shown by Q, should be insulated and preferably flexible. A piece of ordinary lamp cord might be unbraided and serve for these two leads.

Q is a piece of flexible wire leading from the receiving set binding post marked "ground" to a water pipe, heating system or some other metallic conductor to ground, except M (Fig. 1). If there are no water pipes or radiators in the room in which the receiving set is located, the wire should be run out of doors and connected to a special ground below the window, which shall not be the same as the ground for the lightning switch. It is essential that for the best operation of the receiving set this ground be of the very best type. If the soil near the house is dry it is necessary to drive one or more pipes or rods sufficiently deep to encounter moist earth and connect the ground wire to the pipes or rods. This distance will ordinarily not exceed 6 feet. Where clay soil is encountered this distance may be reduced to 3 feet, while in sandy soil it may be increased to 10 feet. If some other metallic conductor, such as the casing of a drilled well, is not far away from the window, it will be a satisfactory "ground."

The Tuner, the Detector, and the Phone

The detector and phone will have to be purchased. The tuner and certain accessories can be made at home.

The tuner, R (shown in Fig. 3), is a piece of cardboard or other non-metallic tubing with turns of copper wire wound around it. The cardboard tubing may be an oatmeal box. Its construction is described in detail below.

The crystal detector, S (in Fig. 3), may be of very simple design and quite satisfactory. The crystal, as it is ordinarily purchased, may be unmounted or mounted in a little block of metal. For mechanical reasons the mounted type may be more satisfactory, but that is of no great consequence. It is very important, however, that a very good tested crystal be used; it is probable also that a galena crystal will be more satisfactory to the beginner. The crystal detector may be made up of a tested crystal, three wood screws, short piece of copper wire, a nail, set-screw type of binding post, and a wood knob or cork. The tested crystal is held in position on the wood base by three brass wood-screws as shown at 1 in Fig. 3. A bare copper wire may be wrapped tightly around the three brass screws for contact. The assembling of the rest of the crystal detector is clearly shown in Fig. 3.

For the phone, T, in Fig. 3 it is desirable to use a pair of telephone receivers connected by a head band, usually called a double telephone headset. The telephone receivers may be any of the standard commercial makes having a resistance of between 2000 and 3000 ohms. The double telephone receivers will cost more than all the other parts of the station combined, but it is desirable to get them, especially if one plans to improve his receiving set later. If one does not care to invest in a set of double telephone receivers a single telephone receiver with a head band may be used, although it gives results somewhat less satisfactory.

The binding posts, switch arms and switch contacts may all be purchased from dealers who handle such goods or they may be quite readily improvised at home. There is nothing peculiar about the pieces of wood on which the equipment is mounted. They may be obtained from a dry packing-box and covered with paraffin to keep out moisture.

The following is a detailed description of the method of winding the coil, construction of the wood panels, and mounting and wiring the apparatus.

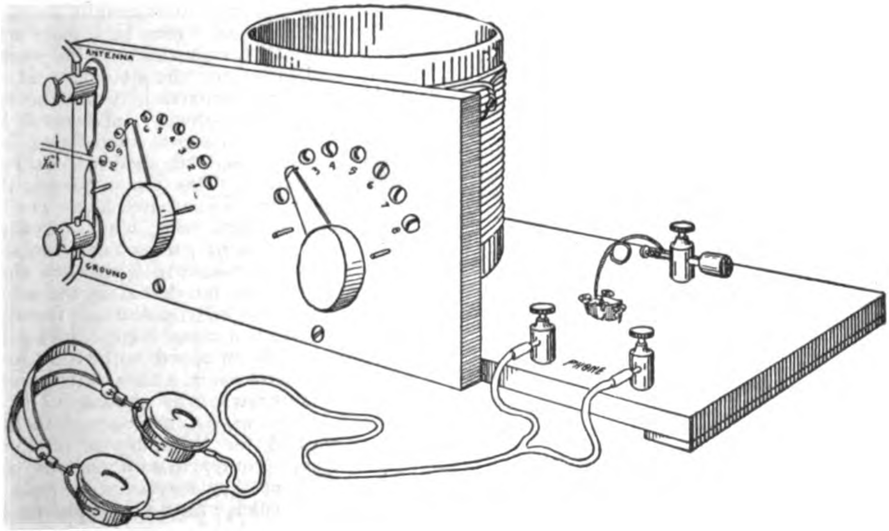


FIGURE 4; *The completed receiver, with the two sets of wavelength switches mounted on the panel and the crystal detector in a convenient place for adjustment.*

I *Fastening the insulated lead in wire to the antenna wire. F is the antenna wire, G is the insulator; H is a piece of rope, I a screw eye and J the lead in wire.*

II *Fastening the far end of the antenna through the metal eye of the insulator. A is the screw eye, B a piece of rope, the insulator and F the antenna wire.*

How to Construct the Tuner

See the tuner, R, Fig. 3. Having supplied oneself with a piece of cardboard tubing 4 inches in diameter and about ½ pound of No. 24, or No. 26, double cotton covered copper wire, one is ready to start the winding of the tuner. Punch two holes in the tube about ½ inch from one end as shown at 2 in Fig. 3. Weave the wire through these holes in such a way that the end of the wire will be firmly anchored, leaving about 12 inches of the wire free for connections. Start with the remainder of the wire to wrap the several turns in a single layer about the tube, tightly and closely together. After 10 complete turns have been wound on the tube hold those turns snugly while a tap is being taken off. This tap is made by making a 6-inch loop of the wire and twisting it together at such a place that it will be slightly staggered from the first tap. This method of taking off taps is shown clearly at U, Fig. 3. Proceed in this manner until 6 twisted taps have been taken off at every 10 turns. After these first 70 turns have been wound on the tube then take off a 6-inch twisted tap for every succeeding single turn until 10 additional turns have been wound on the tube. After winding the last turn of wire anchor the end by weaving it through two holes punched in the tube much as was done at the start, leaving about 12 inches of wire free for connecting. It is to be understood that each of the 18 taps is slightly staggered from the one just above, so that the several taps will not be bunched along one line on the cardboard tube. See Fig. 3. It would be advisable, after winding the tuner as just described, to dip the tuner in hot paraffin. This will help to exclude moisture.

How to Make the Panel and Base

Having completed the tuner to this point, set it aside and construct the upright panel shown in Fig. 2. This panel may be a piece of wood approximately ½ inch thick. The position of the several holes for the binding post, switch arms and switch contacts may first be laid out and drilled. The antenna and ground binding posts may be ordinary ⅛ inch brass bolts of sufficient length and supplied with three nuts and two washers. The first nut binds the bolt to the panel, the second nut holds one of the short pieces of stiff wire, while the third nut holds the antenna or ground wire, as the case may be. The switch arm with knob shown at V, Fig. 3, may be purchased in the assembled form or it may be constructed from a thin slice cut from a broom handle and a bolt of sufficient length equipped with four nuts and two washers, together with a narrow strip of thin brass somewhat as shown. The switch contacts, W (Fig. 3), may be of the regular type furnished for this purpose or they may be brass bolts equipped with one nut and one washer each or they may even be nails driven through the panel with an individual tap fastened under the head or soldered to the projection of the nail through the panel. The switch contacts should be just close enough that the switch arm will not drop between the contacts but also far enough apart that the

III The insulated lead in wire is brought into the house through a porcelain bushing pushed through a hole drilled in the window sash.

IV How the ground lead is attached to the water pipe by means of a ground clamp. Q is the ground wire.

switch arm can be set so as to touch only one contact at a time.

The telephone binding post should preferably be of the set screw type, as shown at X, Fig. 3.

How to Connect the Wires

Having constructed the several parts just mentioned and mounted them on the wood base, one is ready to connect the several taps to the switch contacts and attach the other necessary wires. Scrape the cotton insulation from the loop ends of the sixteen twisted taps as well as from the ends of the two single wire taps coming from the first and last turns. Fasten the bare ends of these wires to the proper switch, as shown by the corresponding numbers in Fig. 3. One should be careful not to cut or break any of the looped taps. It would be preferable to fasten the connecting wires to the switch contacts by binding them between the washer and the nut, as shown at 3, Fig. 3. A wire is run from the back of the binding post marked "ground" (Fig. 3), to the back of the left-hand switch-arm bolt, Y, thence to underneath the left-hand binding post marked "phones." A wire is then run from underneath the right-hand binding post marked "phones" to underneath the binding post, 4 (Fig. 3), which forms a part of the crystal detector. A piece of No. 24 bare copper wire about 2½ inches long, one end of which is twisted tightly around the nail, the nail passing through binding post 4, the other end of which rests gently by its own weight on the crystal 1. The bare copper wire which was wrapped tightly around the three brass wood-screws holding the crystal in place is led to and fastened at the rest of the right-hand switch arm bolt, V, thence to the upper left-hand binding post marked "antenna." As much as possible of this wiring is shown in Fig. 3.

How to Make the Set Work

After all the parts of this crystal-detector radio receiving set have been constructed and assembled the first essential operation is to adjust the little piece of wire, which rests lightly on the crystal, to a sensitive point. This may be accomplished in several different ways; the use of a miniature buzzer transmitter is very satisfactory. Assuming that the most sensitive point on the crystal has been found by method described in the following paragraph, *the Test Buzzer*, the rest of the operation is to get the radio receiving set in resonance or in tune with the station from which one wishes to hear messages. The tuning of the receiving set is attained by adjusting the inductance of the tuner. That is, one or both of the switch arms are rotated until the proper number of turns of wire of the tuner are made a part of the metallic circuit between the antenna and ground, so that together with the capacity of the antenna the receiving circuit is in resonance with the particular transmitting station. It will be remembered that there are 10 turns of wire between each of the first 8 switch contacts and only one turn of wire between each two of the other contacts. The tuning of the receiving set is best accomplished by setting the right-hand switch arm on contact 1 and rotating the left-hand switch arm over all its contacts. If the desired signals are not heard, move the right-hand switch arm to contact 2 and again rotate the left-hand switch arm throughout its range. Proceed in this manner until the desired signals are heard.

It will be advantageous for the one using this radio receiving equipment to find out the wave frequencies, wavelength, used by the several radio transmitting stations in his immediate vicinity.

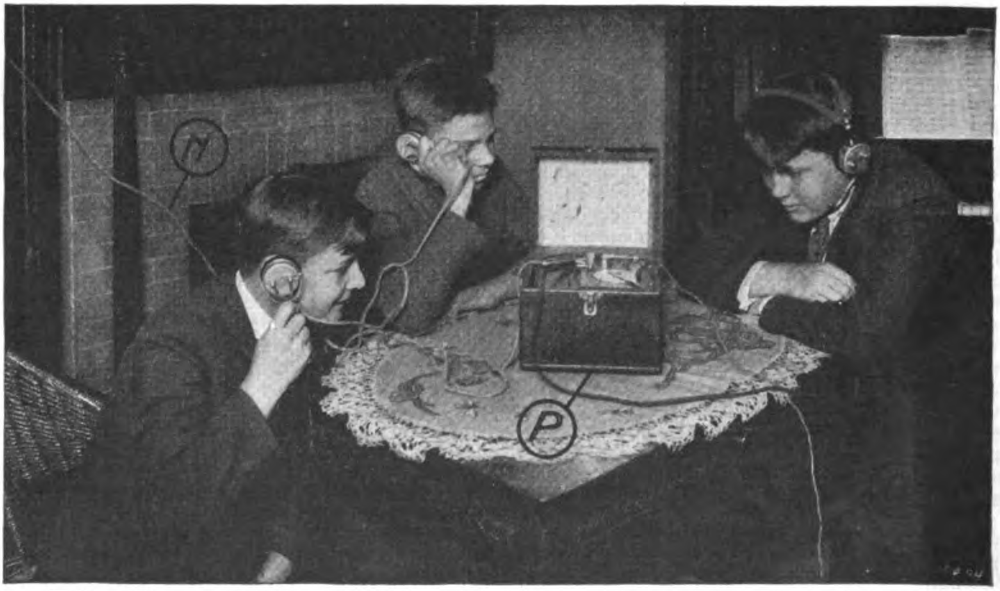
How to Use the Test Buzzer

It is easy to find the more sensitive spots on the crystal by using a test buzzer. The test buzzer is used as a miniature local transmitting set. When connected to the receiving set, as shown at Z (Fig. 3), the current produced by the buzzer will be converted into sound by the telephone receivers and the crystal, the loudness of the sound depending on what part of the crystal is in contact with the fine wire. To find the most sensitive spot connect the test buzzer to the receiving set, as directed, close the switch, 5, Fig. 3, and, if necessary, adjust the buzzer armature so that a clear note is emitted by the buzzer, set the right-hand switch arm on contact point No. 8, fasten the telephone receivers to the binding posts marked "phones", loose the set screw of the binding post slightly and charge the position of the fine wire, 6, Fig. 3, to several positions of contact with the crystal until the loudest sound is heard in the phones, then tighten the binding post set screw, 4, slightly.

What the Set Costs

While the total cost of such a radio receiving station will depend upon the kind of apparatus that is purchased ready made and the number of parts that are made at home, the approximate outlay of money may be listed as follows:

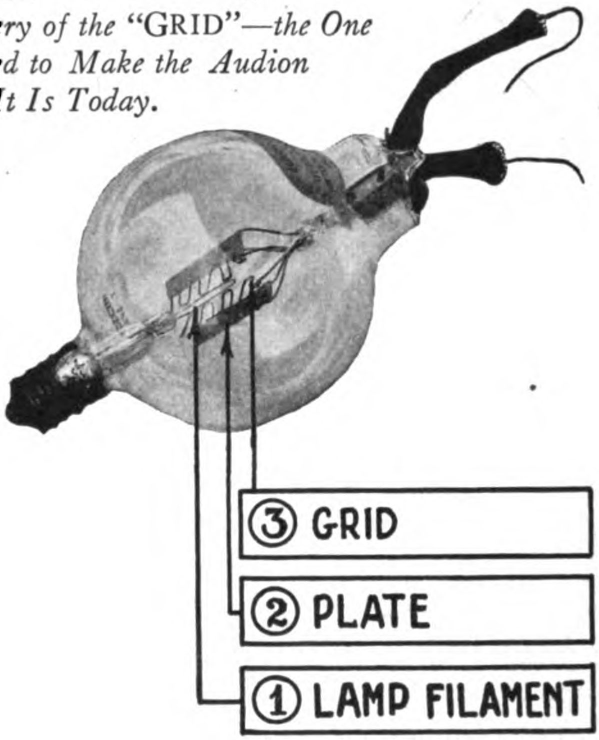
ANTENNA	
Wire—copper, bare or insulated, No. 14, 100 to 150 feet (about)	$0.75
Rope—3/8 or 1/2 inch (2 cents a foot)	
2 insulators, porcelain	0.20
1 pulley	0.15
Lightning switch—30 ampere battery switch	0.30
1 porcelain tube	1.10
GROUND CONNECTIONS	
Wire—(same kind as antenna wire)	
1 clamp	0.15
1 iron pipe or rod	0.25
RECEIVING SET	
1/2 pound No. 24 copper wire, double cotton covered	0.75
1 cardboard box	
2 switch knobs and blades, complete	1.00
18 switch contacts and nuts	0.75
3 binding posts, set screw type	0.45
2 binding posts, any type	0.30
1 crystal, tested	0.25
3 wood screws, brass, 3/4 inch long	0.03
Wood for panels (from a packing box)	
2 pounds of paraffin	0.30
Lamp cord, 2 to 3 cents a foot	
Test buzzer	0.50
Dry battery	0.30
Telephone receivers .... $4.00 to	8.00
Total cost of set...... $11.00 to	$15.00



▼ *The completed installation on the living room table. N is the wire leading out to the lightning switch, (which most amateurs do not provide, although it is a good protection against electrical storms). Q is the ground wire and P is the receiving set.*

"MAKERS OF MODERN MIRACLES" NO. 1

The True Story of the Discovery of the "GRID"—the One Element that Was Needed to Make the Audion Tube What It Is Today.



The Genius Who Put *the* JINN in *the* Radio Bottle

By
JAMES H. COLLINS

YOU remember the bottle drawn up in his net by the poor fisherman in the "Arabian Nights." It held a jinn, or demon, sealed up and cast into the sea by King Solomon. The jinn began to speak to the fisherman, and finally persuaded him to open the bottle and let him out.

There is a speaking jinn in the glass bottle that makes radio telephony possible—the vacuum tube or audion. And thereby hangs a tale.

One summer night, more than twenty years ago, a scientific fisherman was casting his net of investigation into the then little-explored sea of wireless phenomena. And he caught a jinn. Or rather, the jinn spoke to the scientist, not from a bottle, but from a Welsbach gas burner. He was a free jinn, probably having escaped King Solomon. For the first time since he was created with the universe, he spoke to Man, that cosmic infant, and asked to be sealed in a bottle.

And the man sealed him up and set him at work.

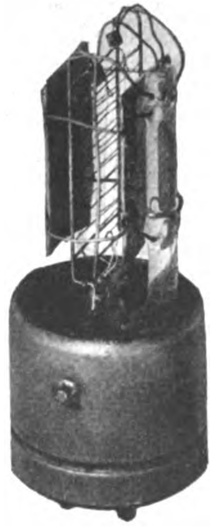
The man was Dr. Lee De Forest, and the place a room in Chicago where he was conducting some night experiments in wireless. De Forest is a parson's son, and a parson's grandson. Born in 1873, at Council Bluffs, Iowa, raised in Talladega, Alabama, where his father was president of Talladega College, educated at the Sheffield Scientific School, Yale University, after serving with the Yale battery during the Spanish-American war, he went to Chicago and got a job in the Western Electric Company's experimental telephone laboratory. There he became interested in wireless telegraphy, and in 1900 quit his job to make independent experiments.

On that summer night he had a new type of electrolytic detector rigged up. His receiving apparatus was placed on a table beneath a Welsbach gas light. In a closet about ten feet away he had a spark coil with which oscillations were made to test his receiving apparatus. The spark coil was operated by a switch closed with a string running across the floor from the table to the closet. Presently De Forest noticed that every time he pulled the string and closed the switch, the light from the gas mantle increased very perceptibly, dropping back to normal when the spark coil was thrown off.

This unexpected behavior of the gas light, which was no part of his apparatus, diverted his attention, and set him thinking. Had he discovered a new form of detector of Hertzian waves of extraordinary sensitiveness? Something in the oscillations from the spark coil affected the gas flame every time the switch was closed—until he closed the door of the closet. Then the phenomena stopped. He had found a detector, not of electrical waves, but of sound waves.

But he had also found a scientific clue. Heated gas molecules were apparently sensitive to high frequency electrical waves.

A year or more passed before De Forest had opportunity to investigate this phenomenon further. The jinn had spoken, but only in the dumb sign language. De Forest went into the gas flame to bring him out and make him talk in a telephone receiver, if possible. He placed two needles of steel, and later platinum, in the incandescent flame, with a gap between, and connected them to a dry battery and telephone receiver. Contrary to his expectations, there was no appreciable current between the two needles in the flame. But when he tried the same experiment with a Bunsen burner he found a point in the outside envelope of the flame where current did pass, making a soft fluttering whisper in the telephone receiver. When one electrode was connected to an antenna and the other grounded in the earth, he heard for the first time signals which clearly represented the sound of the transmitting spark. This proved that his detector principle was right, and he developed the flame type of detector until, in 1903, it was actually used for receiving signals from ships in New York harbor.



A CLOSE-UP OF THE "GRID"

So called because it resembles a gridiron; originally it was made in the form of a wire mesh.

Because a gas flame had obvious inconveniences, he then sought some other means of obtaining the necessary heated gas and heated electrodes. Experiments with the electric arc showed that it was a detector of the same type, but exceedingly irregular and noisy in the telephone receiver—in fact, the impatient jinn now spoke domineeringly, in deafening tones.

Then he turned to the incandescent lamp and found the same detector phenomenon in the more attenuated heated gas surrounding its filament. By a brilliant series of experiments, first with one filament or electrode, then two, and finally the famous "third electrode" or "grid," he developed and patented the "audion" in 1907.

Since then the device has been developed in unforeseen directions, and applied to so many different purposes that the jinn in the bottle has been found a true magician.

The audion is a somewhat complex incandescent lamp.

It has three internal electrodes as shown in the illustration. One is the lamp filament (1) which produces the heat to ope-

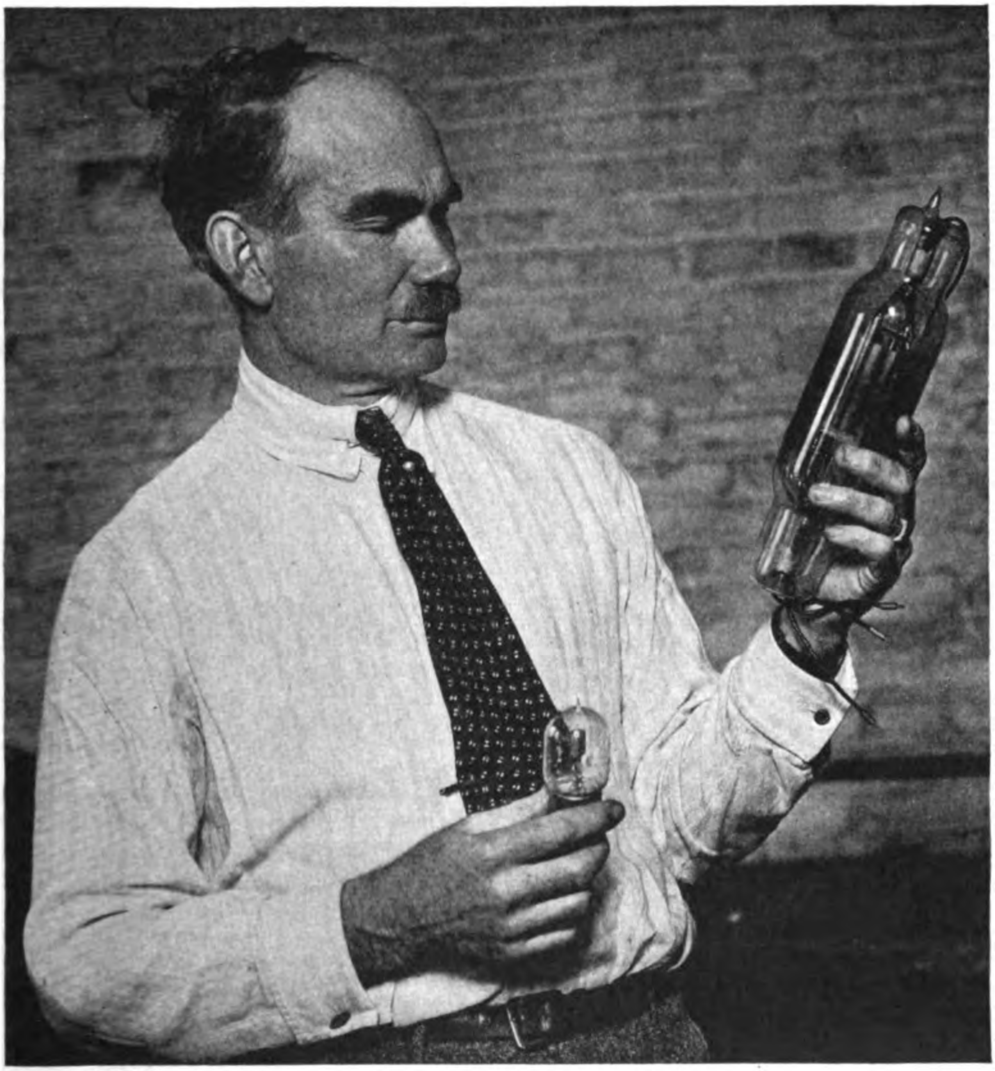


Photo by Paul Thompson

THE BOTTLES THAT HOLD THE GENII

In Dr. De Forest's left hand is the large 250-watt oscillion or "oscillating audion" used for sending radio messages; in his right hand is the small 1-watt audion used for receiving.

rate the device; another is the plate (2) which collects the radio currents flowing from the hot filament, and the third is a wire mesh (3) called the grid, which is placed between them. It is this third electrode that is used by the jinn to perform his miracles.

Its first job was to act as a wireless telegraphy detector of extraordinary sensitiveness. Radio telegraphy had been developed in principle, but its apparatus was so crude that messages could be sent hardly a hundred miles. The necessary high frequency currents were produced by a cumbersome spark coil, but turned into the ether they were lost outside a very narrow radius because there was no detector sensitive enough to pick them up. Practically the only detector then known was the Marconi "coherer," a tube filled with iron filings, which was affected by radio oscillations in but a very limited degree. It required careful attention and frequent adjustment, and was so slow that

ALADDIN'S LAMP

The ordinary audion or vacuum tube, as it is today—a child of the familiar incandescent lamp, and the open sesame to this world of the air.

not more than fifteen words a minute could be received. With the audion, messages were picked up hundreds and then thousands of miles from the transmitting point.

Then the device was found to be an ideal alternating current generator, effecting great improvements and economies in the transmitting end. Alternating current is a pulsating current divided into infinitesimal halves flowing in opposite directions, reversing direction anywhere from a few to many millions of alternations per second. Dynamos were needed to generate it, and they were both expensive and limited. An ordinary dynamo was only capable of alternating current up to one thousand reversals a second, while wireless telegraphy requires from 5,000 to 3,000,000 a second. The jinn in the bottle demonstrated his power to alternate current up to a million and more oscillations a second without any mechanical apparatus whatever. Upon the current flowing from filament to plate inside the bottle, the little grid produced any desired frequency. This was done by modifying the size and type of grid, as well as connecting the audion to outside apparatus.

Wireless telephony was still a laboratory dream. Human speech had actually been transmitted by wireless over short distances, but the necessary alternating current could only be generated by complex and expensive dynamo equipment. Wireless telegraphy requires only a single simple current, which is cut by interruptions into Morse signals. Wireless telephony calls for a mixture of alternating currents of different frequencies to convey the complex talk of the human voice. With a battery of audions at the sending end any desired combination of frequencies could be produced without mechanical apparatus. When telephone engineers went to work with the audion on one hand, and the sudden war demand for wireless telephony on the other, they accomplished marvels in a few months, and blazed the way for the remarkable popular interest in "radio" which has grown up the past year.

THE audion has many other electrical uses. "Versatility" is the inventor's own word for it. It is a receiver, a transmitter, an alternator, an amplifier, a governor—what you will. Just ask the obliging jinn, or put him in the special type of glass bottle in which he can do the sort of work you want. Then leave the rest to him.

This versatility has led Dr. De Forest to center on new applications of the audion, and new types and combinations for different electrical fields, since the original detector type was patented fifteen years ago. But for years he has believed that its greatest service to the public would be along the lines of popular radio telephony, as it is being developed today. More than once a beginning has been made under his direction, one of the first efforts toward setting up a broadcasting service being made by daily newspapers which transmitted music, weather reports and news locally to be picked up with De Forest receiving equipment sold by the newspapers.

This sample of radio whetted popular interest, and led to the organized broadcasting of today, with its daily programs. And that, in turn, is only a beginning, comparable to the phonograph in its infancy when Edison believed that its chief use would be in business offices, not dreaming of its possibilities for putting good music into every home.

Out of the present-day "radio" will undoubtedly grow programs making the musical, educational and recreational facilities of the greatest cities available to people everywhere, with the city apartment and the farmhouse wired for radio just as it is wired for electric light.

A New Broadcasting Station

HAVE you been listening in lately upon a new arrival in the ether? For several weeks unannounced tests have been made that have aroused the curiosity of the amateur who has accidentally picked up the stranger. The newcomer is WGY, operated at the plant of the General Electric Company at Schenectady, New York.

A unique feature of this new station is a switchboard in the studio from which programs are sent; it is flooded with a red light when the station is in operation, as a warning to everyone present that every noise he makes will be broadcasted.

In the apparatus room, the sound waves are put through a number of steps of amplification by means of vacuum tubes which increase their volume thousands of times.

An A. C. voltage is then applied to a number of vacuum tubes, acting as rectifiers, which change the voltage to direct current. Placed between the rectifier and the modulator or molding tubes, is a high power oscillator tube. The electric power entering this tube sets the ether into vibration and upon these vibrations the electric waves, molded into shape in the modulator tubes, are sent to the antenna to go out into space.

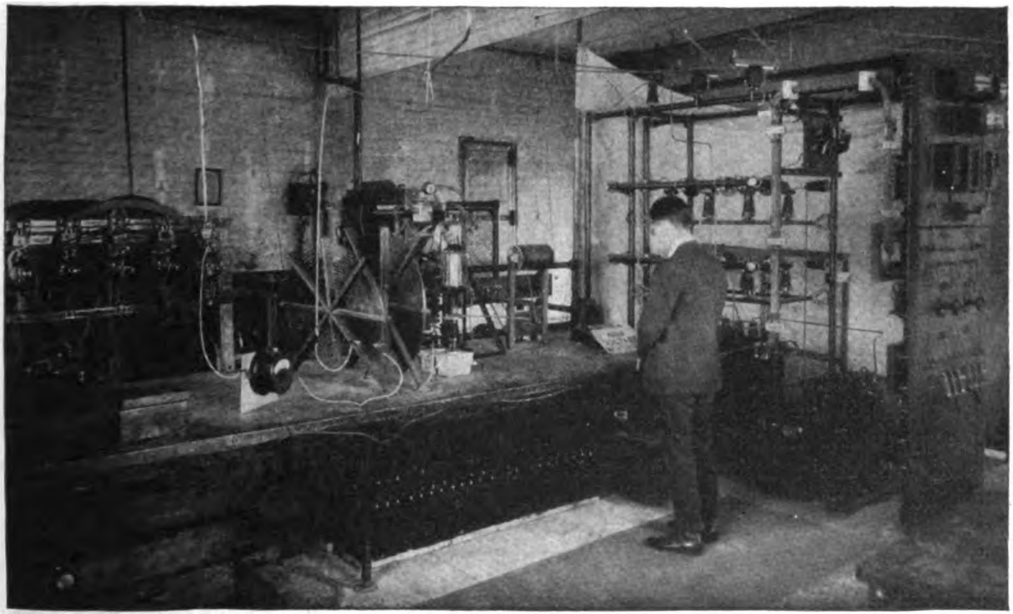
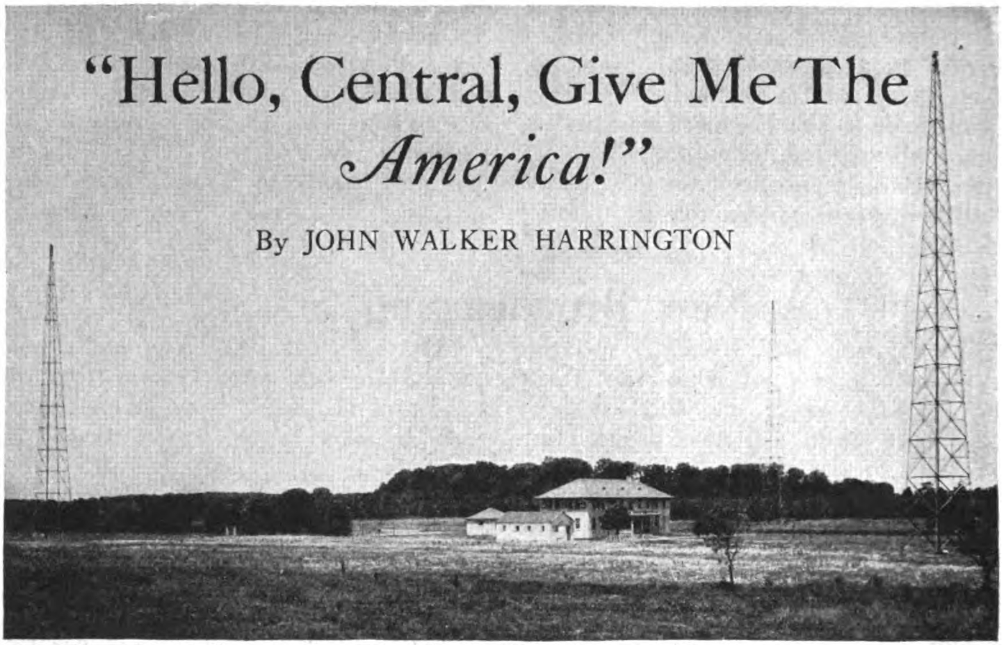


Photo by General Electric

The transmitting room of WGY, showing the tube sets and control board. The studio in which the artists gather is in another building.

"Hello, Central, Give Me The *America!*"

By JOHN WALKER HARRINGTON



From this radio telephone station at Deal Beach, N. J., the tests with ships at sea were conducted.

Were You One of the Many Thousands of Mystified Amateurs Who Listened-In Upon the Recent Radio Tests Between Ship and Shore? This Article Tells How the Experiment Was Successfully Made

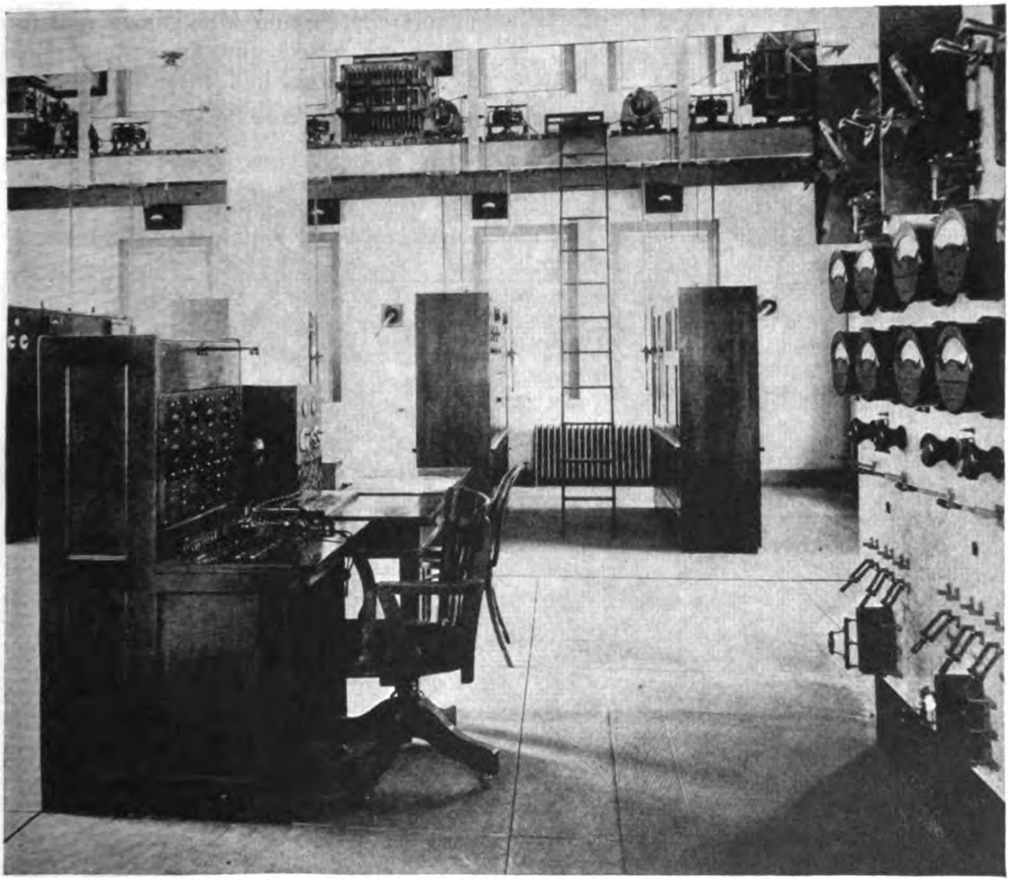
TWO-WAY talk by radio that enables a man at sea to talk over the land telephone lines is the latest achievement of the far-speaking art. The flawless performance which was given when the commander of the incoming ocean liner *America* recently talked when he was 360 miles at sea with H. B. Thayer, who was in his home at New Canaan, Connecticut, is a significant forecast of a new year. Mr. Thayer, as president of the American Telephone and Telegraph Company, is naturally interested in the development of the relations between the telephony of the air and that which follows the throbbing wire. The test in which he took part on the night of March 5 is only one of a series which was begun for the purpose of bringing people in the cities in touch with their friends on ocean-going vessels.

One of these days James Wilberforce Smith, or whatever his name may be, will sit in his stateroom in mid-ocean and call up Mrs. Smith to tell her what he had for dinner. He cannot go into too intimate detail, of course, for owners of radiophones all over the world almost have a chance to listen in. They did just this the other night when Captain Rind and Mr. Thayer were talking of the future of telephony. Radio fans all over the eastern part of the country knew all about the feat, as the conversation was naturally broadcasted.

Experts may not consider it such a remarkable feat to join wire and vibrant air, but the communication of the *America* with the shore did much to make practical a whole lot of theory. That the change can be made satisfactorily was shown by the interesting tests made with the coastwise steamship *Gloucester,* from which speech was first sent by wireless to the shore, then transmitted across the Continent to the Pacific coast, and then relayed by radio once more to Catalina Island. When the World War was over, the company, as radio fans will remember, conducted long telephone communications between Arlington and the Eiffel Tower in Paris.

Many a radio amateur, in a spirit of experiment, has invited some friend who has no receiving set to listen to something choice which he has detected in the air. Merely by placing the receiver of the radiophone over the transmitter of the ordinary telephone, he can entertain an auditor with some entertaining selections. On the lines of this unauthorized practice, and, of course, with much greater precision, the company itself connected up the wireless with its own land wires. To do this it employed its wireless stations at Elberon and at Deal Beach, N. J., and such apparatus as it required in its big operating station in the skyscrapers at No. 24 Walker Street, New York City, where a group of company officials had gathered.

Owing to many factors with which every radio amateur is familiar by experience, there are obstacles to perfect communication which must be overcome in such experiments. The waves used in sending and receiving would have burned each other up, so to speak, had the two stations not been separated by the mile and half of sands. The voice of the cap-

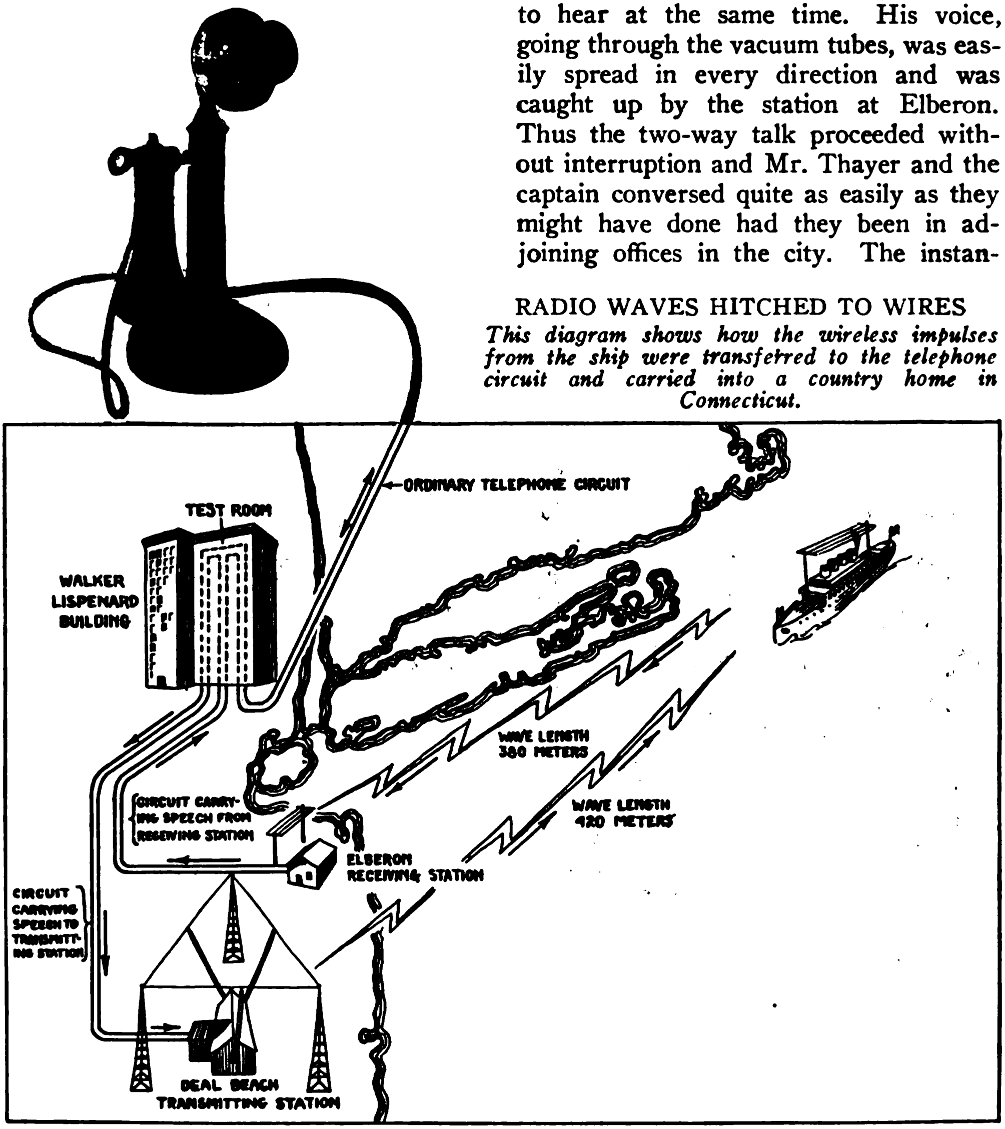


WHERE THE RADIO CALLS WERE RECEIVED

At the desk in the foreground sat the operator in the Deal Beach Station when the two-way conversation with the America *was carried on. The tube sets are in the background and the antennae connections are on the balcony.*

tain of the *America*, as is shown in the accompanying diagram, was carried over the sea for one hundred and twenty leagues to the Elberon station. There it was so modified that its waves were made of such frequency as to make them audible over the land lines with which it was connected. When Mr. Thayer replied to Captain Rind his voice followed the metal strands to the station at Deal Beach, and were then amplified and cast out into the air, where they were duly received on board the steamer. The two stations, on the New Jersey beach, although so widely separated, were doing fine team work. The two currents—the going and the coming current—as far as the ship was concerned, passed through the plant in Walker Street, where greater power was imparted to them, for distribution to the telephone subscribers who cared to listen to this historic interchange of greetings.

By the use of various duplex devices the captain of the *America*, who did not have a mile and a half of beach for leeway, was able to talk into the phone and to hear at the same time. His voice, going through the vacuum tubes, was easily spread in every direction and was caught up by the station at Elberon. Thus the two-way talk proceeded without interruption and Mr. Thayer and the captain conversed quite as easily as they might have done had they been in adjoining offices in the city. The instan-


ORDINARY TELEPHONE CIRCUIT
TEST ROOM
WALKER LISPENARD BUILDING
WAVE LENGTH 380 METERS
WAVE LENGTH 420 METERS
CIRCUIT CARRYING SPEECH FROM RECEIVING STATION
ELBERON RECEIVING STATION
CIRCUIT CARRYING SPEECH TO TRANSMITTING STATION
DEAL BEACH TRANSMITTING STATION

RADIO WAVES HITCHED TO WIRES

This diagram shows how the wireless impulses from the ship were transferred to the telephone circuit and carried into a country home in Connecticut.

taneous replies to questions and greetings was an admirable demonstration of the new method.

It is a bit early to predict just how far-reaching this innovation will prove to be. It certainly should become of great value for communications between captains of vessels and the agents or owners ashore. Instead of a long interchange of wireless telegrams, it would give the same direct and clear understanding of orders as might be obtained by those concerned had they sat facing each other across a flat top desk. The need of just such direct interchanges has often been apparent in emergencies.

While the functions of radio and wire transmissions are so radically different, yet they may be harmonized in many ways. The message which comes by wireless over many liquid leagues may in the first place be caught by the receiving sets of many alert fans. This was actually the case when the *America* was approaching. For the ordinary purpose of business, however, the network of land wires that reach all parts of the nation by telephone and telegraph are a powerful aid in the dispatching of information which is sent in throbbing from the realms of ether. The outcome of the latest liaison between wire and wireless will be followed closely by the disciples of radio.

A Wave Cycle *from* Cathay

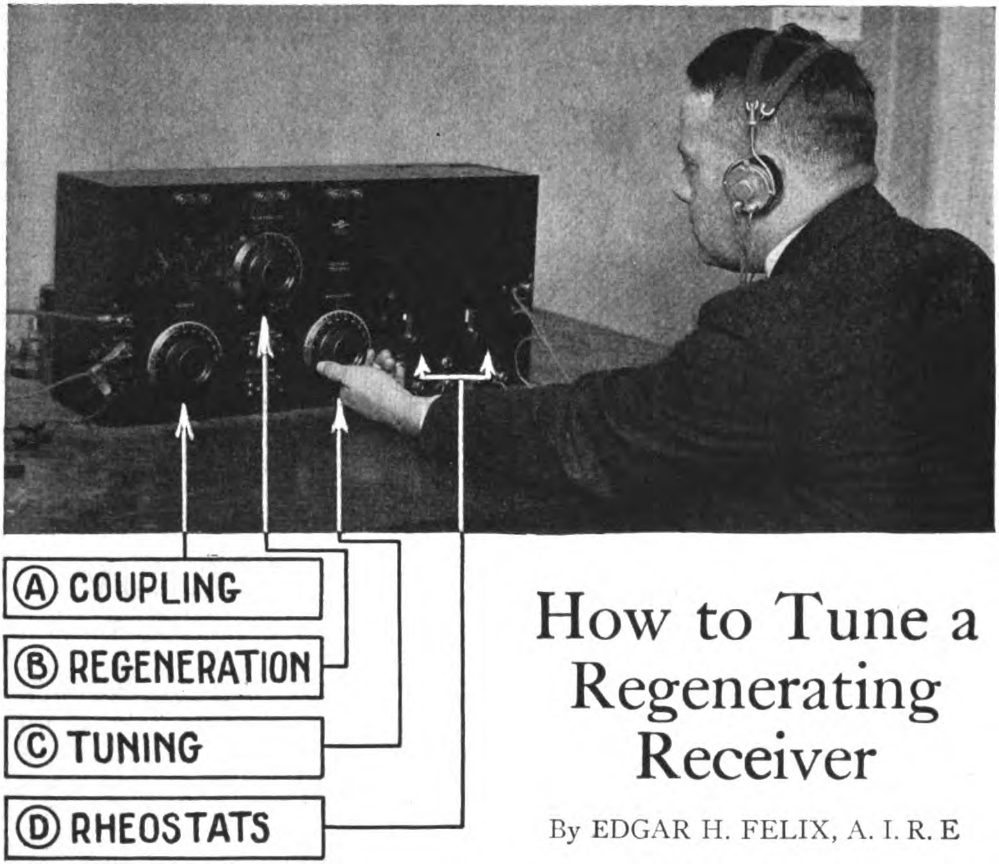
Soon We Will Hear the Temple Bells of Ancient China—by Radio

By C. DICKSON LOOS

IN old Cathay, where temple bells break the peaceful stillness and lazily floating junks ripple the waters, and which has basked in dreamland for four hundred centuries, there is now being erected one of the highest powered wireless stations in the world. It will establish the first direct communication between China and America.

In January, 1921, the Chinese Ministry of Communications signed an agreement with the Federal Telegraph Company of California for the erection of a high power wireless station of 1000 kilowatts at Shanghai, and for less powerful installations at Peking, Hankow, Canton and Harbin. Although the contract was concluded more than a year ago, actual work on construction has just been begun in Shanghai. This delay was due to protests from Great Britain, Japan and Denmark, who are jealous of American competition in the Orient. Claiming that the new agreement with the American company was a violation of the contract rights of their own countrymen, the Marconi Wireless Company, Limited, the Mitsui Company, and the Great Northern Telegraph Company, the British, Japanese and Danish diplomats made every effort to block the Federal contract. For a time the Chinese Government wavered under this strong diplomatic pressure. Secretary Hughes, however, made the question a test of the "Open Door" policy in China, and pointed out that the exclusion of Americans in the wireless field was a clear case of monopoly and meant the closing of China's "open door." Abandonment of that policy would be a catastrophe to China politically and well as commercially.

The outcome of the dispute was victory for the American company. Actual construction is now under way at Shanghai. The most important feature of the contract is the establishment of direct communication between China and America. No longer will messages have to be relayed by way of Guam and Japan, as in the past. In case of war on the Pacific this will be of inestimable value to America. And it is a milestone in world history —this final link with age-old Cathay.



How to Tune a Regenerating Receiver

By EDGAR H. FELIX, A. I. R. E

Have You Ever Heard Clearly Over Your Radiophone One Day—and Been Disgusted with the Results the Next? The Chances Are That Your Adjustments Were Faulty

THE sudden awakening of popular interest in radio telephone broadcasting and the consequent demand for receiving sets has placed thousands of delicate bits of mechanism in the hands of novices who have had no experience in adjusting them. The average novice regards the problem of adjusting his set as merely a matter of setting his controls in such a way that will enable him to hear the station he wants.

This haphazard and illogical method of tuning, although it may bring results after a fashion, robs the listener of much of the joy of receiving. Unskilled tuning results in weak signals, interference and uncertainty.

The tuning of a radio receiver is simple enough if the functioning of the few simple controls are known to the operator.

The usual regenerative vacuum tube receiver has the following controls, as illustrated in the diagram at the top of this page:

A Coupling.
B Regeneration.
C Tuning { Antenna wavelength, Secondary wavelength.
D Filament rheostats.

In some sets on the market, controls A and C are combined in a single control which adjusts the wavelength of both primary and secondary circuit. Some of the sets of the more inexpensive types are designed without a secondary circuit, with the consequent sacrifice of selectivity. However, in all cases the process of adjustment is somewhat similar.

There are three adjustments which are made before the operator attempts to receive any particular station:

First, the aerial switch is placed in the receiving position;

Second, the filaments of the tube or tubes are lit, either by means of special switches employed for the purpose or by the automatic jack, which completes the filament circuits when the plug connected with the telephone receivers is inserted in the jack.

Third, the adjustment of the filament rheostat. This is gradually turned up until a slight hiss or roar is heard in the receivers. The resistance is then turned back slightly until that noise is just inaudible.

The operator is now ready to tune his set. The control knob, marked "regeneration" or "tickler," is placed at minimum.

The first step in tuning for a particular station is to adjust for wavelength. In most of the receivers that are being sold for broadcasting there is but one adjustment for this purpose; with such sets it is merely necessary to turn slowly from minimum to maximum, stopping at any point where a desired station is heard.

Some receivers are equipped with a vernier adjustment, which provides fine graduations of the main wavelength adjustment. With a set so equipped (after the rough tuning has been made in the manner just described), the signal is more accurately tuned by means of the vernier adjustment.

For receivers that have separate controls for the primary and secondary circuits, the tuning process is slightly modified. In this case to tune in correctly a particular signal both primary and secondary circuits must be adjusted to the wavelength of the desired incoming signal.

A rough adjustment of the primary circuit is first made. If the operator has no knowledge whatever of the approximate adjustment for any particular wavelength, he adjusts the primary circuit to one third or one half its maximum value. If the coupling between the primary and secondary circuits is adjustable, it is placed at maximum during the first step of the tuning process. By maximum is meant that position in which the secondary windings are closest to or parallel with the primary windings.

The wavelength of the secondary circuit is then made in the same manner as first described for the primary adjustment of the single control receiver. When the desired signal is then properly tuned in on the secondary circuit, a re-adjustment of the primary circuit is made until the point at which the signal is heard with maximum loudness is found. In some cases, a slight re-adjustment of the secondary circuit is again advisable with the result that the signal is heard with greatly increased strength.

The advantage of separate controls for primary and secondary tuning and the mutual coupling between those two circuits lies in its selectivity. If adjustments have been completed as described, and an interfering station starts in sending, it is merely necessary to decrease the coupling between primary and secondary circuits and then to re-tune the primary and secondary circuits again. Almost invariably it is possible to find a position of coupling in which the desired station is heard and the interfering station eliminated.

Once the correct adjustment for wavelength has been made, it is a simple matter to adjust the "regeneration," "tickler" or "feedback" control. This is done by slowly turning the control knob from the minimum position toward the maximum. At first this action may not produce any perceptible result; then there will be a sudden and surprising increase in signal strength. But if you increase regeneration too much, the quality of the received signals becomes distorted. At first only the high notes are affected. If the adjustment is turned still further to maximum, the music becomes completely distorted and its tonal qualities are destroyed.

It is desirable to sacrifice signal strength in order to obtain full advantage of the purity and perfect tonal qualities of radio telephone music. The temptation is to obtain the loudest possible signal at the receiver, but the discriminating operator knows he is not striving to receive the maximum noise but the most enjoyable and most faithful reproduction of the music that is being sent out.

As a measure of economy, minimum filament brilliancy consistent with the reception of the desired signals at audible strength should be employed. When receiving music with the regeneration adjusted to its point, a reduction of filament brilliancy at once causes a cessation of regeneration. But, by increasing the degree of regeneration, the reduction in filament brilliancy can be compensated for up to the point at which regeneration is at a maximum. It is usually unnecessary to burn tubes at white heat and it is very disastrous to their long life. Consequently maximum filament brilliancy should be avoided if regeneration takes place at lower filament temperatures.

The process of tuning a regenerative receiver may be summarized as follows:

(1) *How to Make Preliminary Adjustment*:

a. Turn the antenna switch to the receiving position.
b. Light the filaments by turning on the filament switch or inserting the plug into the jack which completes those circuits.
c. Adjust filament brilliancy to the highest point at which no roar or hiss is heard in receivers.

(2) *How to Tune:*

(In the case of single circuit receivers and single control receivers):

a. Adjust the main wavelength switch until the desired signal is heard.
b. Adjust the vernier, in the case of two circuit receivers:
a. Make an approximate adjustment of the primary circuit.
b. Carefully tune the secondary circuit until the desired signal is heard, with the coupling at the miximum.
c. Retune the primary circuit.
d. Make the final slight adjustment of the secondary circuit.
e. In case of interference, change the coupling and retune the primary and secondary circuits.

(3) *How to Adjust the Regeneration*:

a. Gradually increase the degree of regeneration from its minimum position until a sudden increase in amplification is heard; continue very slowly to increase until the note begins to be distorted.
b. For purposes of economy, slowly reduce the filament brilliancy and simultaneously increase the regeneration until the regeneration is at a maximum without loss of amplification or distortion.

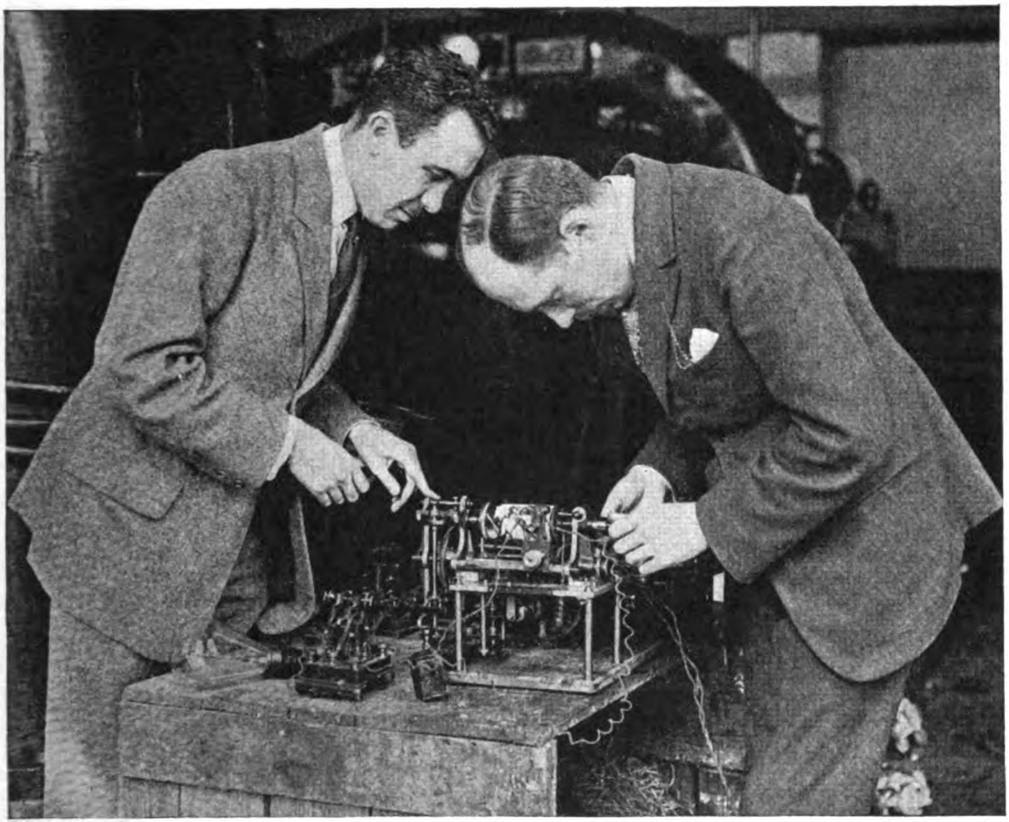
With these instructions clearly in mind the novice should meet with little trouble with his newly acquired apparatus.

ANOTHER "SMALLEST RECEIVER"

STILL another "smallest radio receiving instrument in the world" has been completed, this time by Alfred J. De Giovanni, a fourteen-year-old freshman in the Union High School at Knoxville, Pa.

His tiny instrument is slightly less than one inch square, not much larger than a nickel, but is said to record distinctly in Knoxville the programs of the large broadcasting station in East Pittsburgh, a distance of about fifteen miles.

Young De Giovanni has been making wireless outfits more than three years.



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THE FIRST STEP TOWARD TELE-VISION

This is the transmitter of the apparatus invented by Edouard Bélin for sending pictures by radio, an adaptation of his invention for transmitting photographs over wires.

The Next Step Ahead *in* Radio

Will We Soon SEE *by Wireless? Will Power for Driving Machinery Be Broadcasted? And When Lightning Is Harnessed, Will Bloodless Battles Be Fought by Engines Run by Radio?*

By WALDEMAR KAEMPFFERT

WHEN the announcer at the broadcasting station proclaims to twenty thousand listeners that "Signora Racillini, formerly of La Scala, Milan, will now sing Tosti's 'Good-Bye,'" and when the Signora pours out her full-throated best, a complicated process occurs. The pulsations of the voice—the inflections, the liquid flow of vowels, the puffs and hisses of consonants—are first converted into electric waves that ripple out through the ether with the speed of light, and the waves are then reconverted into sound at thousands of receiving sets by telephone receivers. From beginning to end the process is a manifestation of energy. The Signora simply modulates ether waves as she sings, and the ether waves are energy waves. About one hundred and fifty horsepower would have to be placed at her disposal if she wanted her "Good-bye forever" to reach Europe.

To hear the Signora may be satisfactory enough to the ear. But I want to *see her,* too. The radio telephone is an instrument for miraculously extending the range of the human voice. Can the radio engineer similarly extend human vision? If I in Toledo can hear the broadcasted voice of Galli Curci as she sings on the stage of the Metropolitan Opera House in New York; will the time ever come when I shall at the same time behold her?

The possibility seems staggering. To translate a voice first into waves of ethereal energy and back again into song or speech seems awe-inspiring enough in these days of radio marvels. But what shall be said of sending a living, moving personality through the ether—a figure that will be as intangible and yet more realistic than any motion picture, a figure that looks like Galli Curci and suits the action to the word, something that we will swear *is* Galli Curci?

Inventors have dreamed of the possibility. They have even made a few crude attempts at converting the possibility into a reality. It so happens that they have in selenium an element which is curiously responsive to light. The electric conductivity of selenium varies with the amount of light that falls upon it in a given time, and in that mysterious property lie possibilities of broadcasting the appearance, the gestures, the form of Galli Curci to millions of receivers.

Radio opera in the year 1972 will be optically and aurally as gratifying five hundred miles from the stage as if the vast audience were seated in the auditorium itself. Whole nations, perhaps all Europe and America, will be converted into a planetary opera house. Madagascar and Oklahoma, Norway and South Africa—half the world—will follow not merely the voices but the figures of Tristan and Isolde as they enact the greatest love tragedy ever written. Will there be just one opera in all the world, a super-opera with a super-orchestra and super-singers—an opera produced with a magnificence that eclipses anything that Paris or New York has ever attempted?

Why not?

Perhaps there will be small opera receivers for the home, and large receivers for local theatres thronged every night by hundreds who will follow on the screen the movements and voices of electrically transmitted personalities undistinguishable from their human originals in Paris or New York. Lima, Ohio, will be operatically as well off as any metropolis of Europe or America.

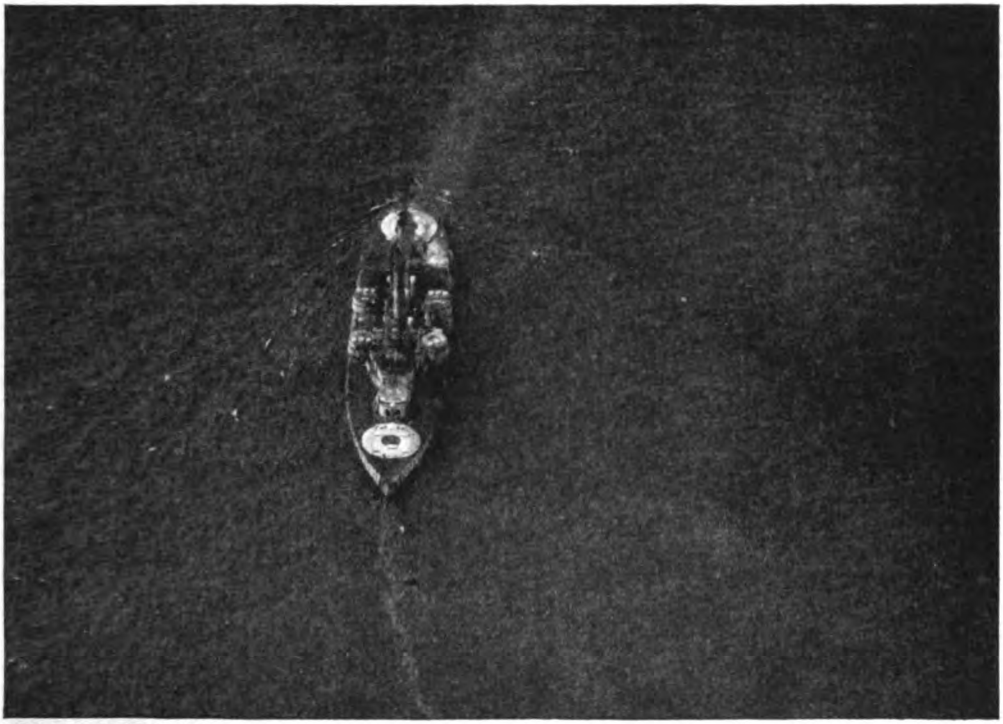
Perhaps the first step in the realization of what may seem now but a technical fantasy will be the transmission of photographs by radio. Knudsen, a Dane, made a few promising experiments in sending pictures by wireless ten or fifteen years ago. Creed, in England, has done even better within the last two years. The step from transmitting the elements of a lifeless photograph, a "still" in screen parlance, to broadcasting a moving picture can easily be imagined. And then will come the radiation into the ether of the human figure itself, at first in black and white and then in the colors of nature.

WHEN we listen to broadcasted opera we listen to transformed energy. If we can make a moving tape record telegraph signals or a telephone diaphragm vibrate to reproduce a human voice hundreds of miles away, we can also make other contrivances act. Clocks have been started and stopped by radio, lights have been turned on and off, a dozen different machines have been controlled by pulsations of waves sent through the ether, and all this long before radio broadcasting became the vogue.

Recently the United States made the interesting experiment of trying to sink one of its obsolete battleships with bombs dropped from airplanes. The old *Iowa* was the target. To mimic the conditions of battle as closely as possible the battleship maneuvered under steam.

With men on board?

Not at all. The captain of the ship was miles away. And the crew? There was no crew—only a specially designed



Official Photo, U. S. Navy

A REAL U. S. BATTLESHIP RUN BY A PHANTOM CREW.

Not a living man was aboard the "Iowa" when she was manoeuvred at sea during the recent aerial bombing tests. She was controlled entirely by radio waves directed from a point miles distant; the guns might have been similarly directed.

receiving apparatus which controlled the machinery. The captain had only to send out waves in a certain sequence, and the ship would move to starboard or to port, proceed straight on under full steam, or stop dead. He might have trained guns and fired them had there been any good reason for doing so.

All this makes one wonder if the naval battle of the future will be an encounter, not of ships thronged with men cheering as they see an adversary settle by the stern and plunge beneath the waves, but of lifeless ships, of naval machines rather than of vessels manned each with a crew of twelve hundred or more. The movements of either side are reported by scouts in the air and plotted on a chart. The opposing admirals control the movements of their floating machines from some safe fortification on the coast. A battle will be more than ever like that game of chess to which it is so frequently and so aptly likened. The admiral who loses all or most of his naval machines at once notifies his government to make the best peace terms that it can. Not a drop of blood will be shed, and yet the destinies of nations may be decided.

WHEN we read of crewless battleships maneuvering in response to signals we are dealing with no extraordinary demonstration of radio's possibilities. After all the signals act like the pressure of the finger on the trigger of a gun; they simply set local mechanism in motion. The machines are not actually driven by the waves in the ether. This is the dramatically startling possibility to which Nikola Tesla bids us look forward.

A broadcasting station is but a power house of a special type. It radiates energy which we use only for communicating thought.

Why not broadcast energy to drive machines?

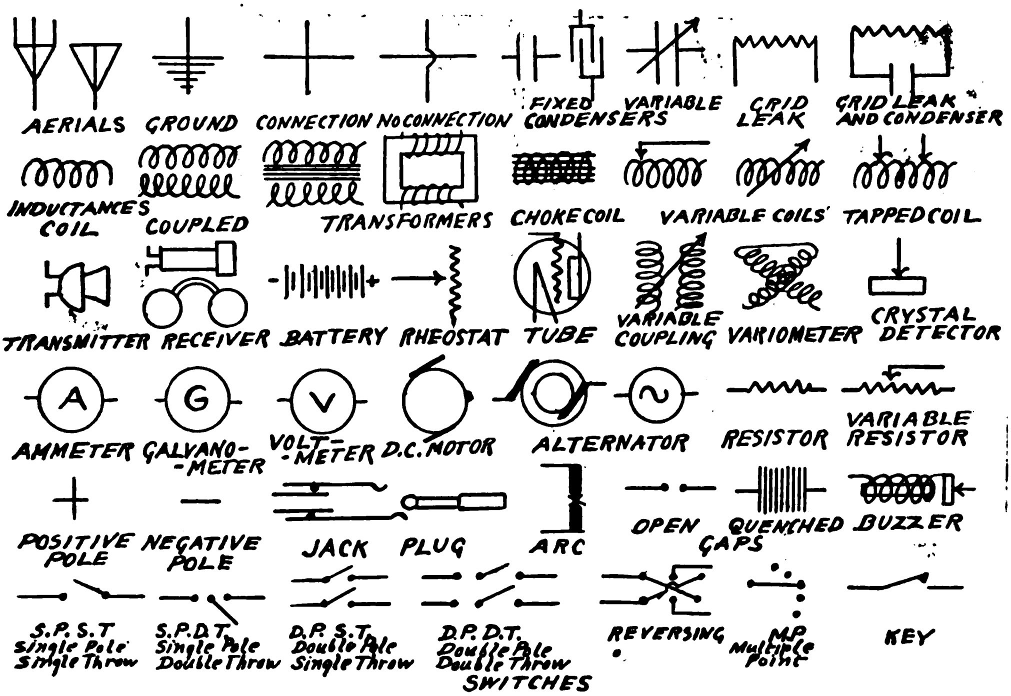
Tesla has succeeded in wirelessly lighting electric lamps at distances of a hundred feet and more from the source of radiant energy and dreams of cities and homes electrified with power radiated from some colossal station. His plan for broadcasting power depends in large measure on resonance, and what that is anyone who has ever started a pendulum beating with a slight tap of the finger ought to know. Keep on tapping the pendulum at just the right interval, and the beat increases in amplitude steadily. The taps must be correctly timed, and this is what is meant by "resonance." Suppose that it were possible to construct a receiving apparatus which could be thus electrically tapped, as it were. Suppose, in other words, that the waves would arrive at just the right intervals to reinforce the surgings of current in the receiving circuit. Suppose that it were thus possible to pile electric impulse on electric impulse until the accumulation of them all in a properly tuned circuit would represent millions of horsepower in electric oscillations. Suppose that there was a way of turning part of that unthinkable amount of power into a motor to run a street car, light electric lamps, and perform other useful work. Surely the radio millenium would seem to have arrived.

BUT a possibility still remains that dwarfs even this. It is the possibility of harnessing "static." Now that thousands are "listening in" every night to broadcasted concerts and lectures the term "static" promises soon to pass into the vernacular. "Static" is the sputtering, grinding and hissing that sometimes obscures reception and in summer occasionally makes it all but impossible. What is it? Simply nature's own enormous broadcasting station sending out waves into the ether, which our instruments pick up if they happen to be tuned to the same wavelength. Whenever lightning leaps between cloud and earth or between cloud and cloud nature is sending out a crashing radio signal.

These manifestations of "static" are manifestations of energy, as much so as the broadcasting of speech and song. Can we tap this energy? Must we always be dependent on machines to generate the electric energy that our broadcasting stations hurl out into space? Sometimes we read of imaginative swindlers who claim to have "tapped atmospheric electricity," to use their own rhapsodical phrase, and who succeed in selling stock in a company which dies almost as soon as it is born. And yet in back of this swindling and of this apparent madness is the germ of a possible invention. We still speak allegorically of Franklin "harnessing the lightning." Conducting static electricity down a wet kite string is not "harnessing" anything. No one has yet harnessed the lightning. But radio is even now fashioning the harness. After all, Marconi first signalled through space with waves generated by miniature artificial lightning flashes, and before Marconi made his experiments, Popoff, a Russian, had received radio signals from distant cloud discharges. Lodge and a dozen others have thus literally drawn off infinitesimal amounts of atmospheric electricity—"static."

But how is this vast atmospheric reservoir of electricity to be drained? No one can ever guess. "Static" is always present. Waves of many different lengths are constantly being sent out. Perhaps Tesla's principle of resonance may be applied, perhaps electrical vibrations can be piled up on the same principle that enables a tapping finger to increase the swing of a pendulum enormously. But whatever the principle may be it is not altogether a wild dream to imagine a world running its factories and its trains with energy drawn from the atmosphere.

When that time comes the lightning will be really harnessed.



Symbols *That* Help in Reading Diagrams

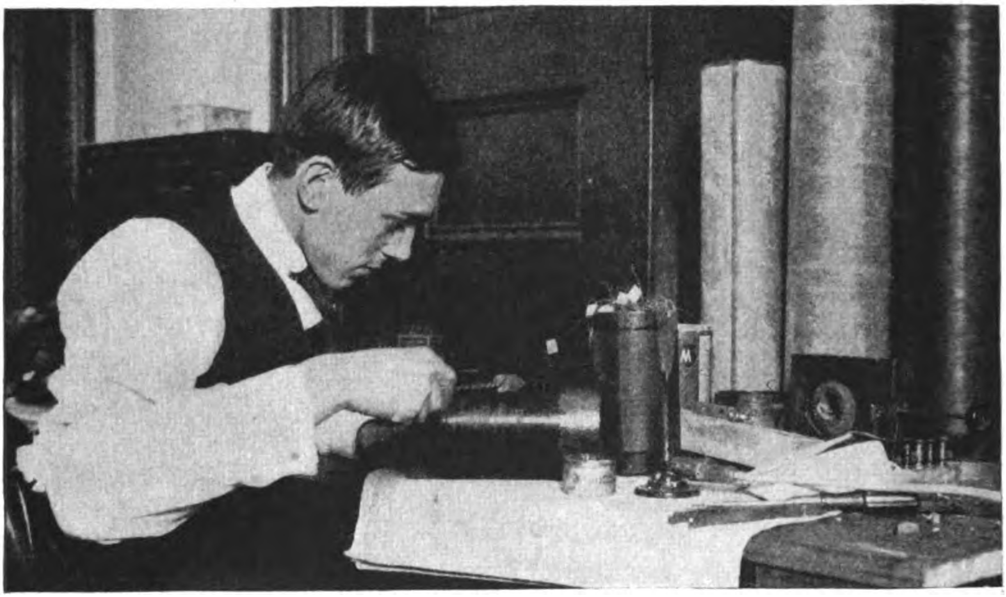
By A. HYATT VERRILL

MANY amateurs who want to build or install their own radio sets, or to add to them, find themselves at a loss when they turn to the various magazines and books that publish diagrams. As a rule, the diagrams convey no meaning to the layman, for instead of having the various devices and instruments plainly labelled, or in the least resembling the originals, they are indicated by symbols.

The symbols used in radio are comparatively few and are shown in the accompanying illustration.

Do not, however, make the mistake that was made by an amateur who, seeing the symbols representing the primary and secondary coils of an inductance coil drawn side by side, constructed his coil in that way and wondered why his set would not work! Inductances are represented side by side in the diagrams merely to avoid confusion of lines, and the two windings should invariably be placed one over the other.

Also, bear in mind that diagrams of wiring are always shown with the wires running straight, parallel and with square corners and with a great deal of space between them. This is done for the sake of appearances in the drawing, ease in drafting and to render "reading" the diagrams easier. In following such a diagram the wires may be carried at any angle, in curves or around corners and may be placed much closer together than is indicated. If you should examine a ready-made set you would find instruments and wires packed closely together with the wires far from straight and parallel. Indeed, it is an unwise plan to carry wires parallel for any distance, as there is always a tendency to "induced" currents when this is done. The main points to remember are to cross wires as seldom as possible; to keep them well separated where they cross; to keep them as short as possible; to have them well insulated and to make good connections.



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How *to* Make Soldered Connections

Useful Tips for the Amateur Who Wires His Own Radio Set

By FREDERICK SIEMENS

WHEN wiring up a radio set it is important that all connections be made so that a good positive junction is formed not only between the wires and the instruments but also between the wires themselves.

There are four points to be remembered when making up a soldered joint: *First,* the surfaces of the parts that are being joined should be cleaned and polished; *Second,* the surfaces should be treated with a soldering flux; *Third,* the temperature of the soldering iron should be kept at the right heat; *Fourth,* the metal parts should be heated with the iron and just enough solder applied to cover the parts neatly.

If these precautions are taken, every joint will be a real joint, and the apparatus thus connected up will function in a quiet, clear manner, without any of the hissing, scratching, or crackling sounds that always accompany a poorly connected set.

All metal parts to be joined should be rubbed and polished to a bright, shiny finish, with emery cloth. All coverings such as lacquer, grease or oxidization should be removed from the surface of the metal.

The purpose of using the soldering flux is to cause the molecules of metal to amalgamate with the molecules of molten solder which will be applied later. There are a number of fluxes the chemical constituents of which cause this action to take place. This soldering paste may be applied with a small stick. Use only enough to cover the surfaces with a thin film, however; excessive use of paste causes a dirty joint.

A small one-half pound iron (which, by the way is made of copper), should be used. To prepare the iron, clean the point with a smooth file or emery paper to a distance of about one-half an inch from the point, and then place the iron in a clear gas flame and heat it until a green tint is seen in the flame around the iron. Then apply the soldering flux to the point and rub a piece of solder over the cleaned surface until it is covered with a coating of solder. Then place the iron back in the flame but keep the point out of the flame. The iron should never be heated beyond the temperature at which the solder begins to turn dull gray. Remember that if the iron gets too hot it will oxidize and the solder will not stick to it and it will have to be cleaned and tinned all over again. Of course an electric iron is preferable, because the possibility of overheating is forestalled, as the iron is designed to work at the correct temperature only.

When the iron is at the correct temperature, place the point of it on the surfaces of the wires or parts to be joined, and heat them for a moment while the flux bubbles up; then place the end of the strip of solder on the parts until enough melts and flows over the surfaces to make a neat joint. Do not use any more solder than absolutely necessary. Work the molten solder around with the point of the iron, until every crevice is filled, and then take away the iron and refrain from moving or disturbing the joint until the solder "freezes" or sets. Wipe off all excess soldering flux and the job is complete. The handiest kind of solder to use is a soft solder put up in the form of a wire about one-eighth of an inch in diameter.

After a few trials the process becomes simple, provided these precautions are taken. And the results obtained from the completed instrument will be well worth the effort.

How Radio Waves Are Sent *and* Received

THE FIRST OF A SERIES OF SIMPLE "HOW" ARTICLES FOR THE BEGINNER

By LAURENCE M. COCKADAY, R. E.

A RADIO wave is a vibration of the ether, that supposed substance that fills space.

There are many different kinds of vibrations that travel through the ether; that is to say, certain vibrations produce entirely different results than other vibrations.

Suppose we consider, for example, a flexible reed, fastened to a stationary base as shown in Fig. 1. If we cause the reed to vibrate it will first take the position "A," and then swing back and past its original position to a third position "B," and then back to its original position again. Then the same series of movements will be gone through again. This complete set of movements is called a cycle. A cycle then, is composed of two impulses, one in one direction and another in a reverse direction.

Now if we cause the reed to vibrate at a speed of 16 cycles a second, the reed will cause a sound wave to be propagated in the immediate space surrounding it. This wave will make itself manifest to our senses in the form of a low humming sound. Close by the reed the sound will be fairly loud, but at a distance of fifty feet it may be inaudible.

If we increase the frequency (or speed of vibration), to 500 cycles a second, the low hum will increase in pitch until it will be a shrill whistle, like the high notes of an organ.

If we continuously increase the frequency of the oscillations, when we have the reed oscillating at a frequency of

25,000 cycles a second, the sound will have gotten so high that the human ear cannot hear it. In other words, the waves that are generated around the reed have gone out of the range of frequency that we call sound waves.

As the frequency is increased it will be soon noticed that the reed begins to get warm, until, finally, by placing the hand near it we "feel" the heat wave. This heat wave is of exactly the same nature as the sound wave except that it has a different frequency and produces different results. In one case we hear the sound, with a sound recording organ called the ear, and in the other case we feel the presence of heat by our sense of touch.

As the frequency of the little reed is increased beyond this point, the heat developed finally increases until the reed begins to glow a dull red color. Instantly the wave has become a light wave and it is visible to our eyes, but the heat is still felt. This shows that the ranges of heat and light overlap in the frequency scale.

Any further increase of frequency would mean destruction to the reed through overheating, but if we could imagine its frequency as increasing without burning up, the waves sent out would pass through the ranges of color and the X-ray.

To sum up the foregoing, different ranges of frequency, say 16 to 25,000 cycles, produce waves that we call sound, and another range produces heat, light and color. Another range produces X-rays, and a similar range produces waves which we call Hertzian waves, named after Hertz, the man who discovered their existence.

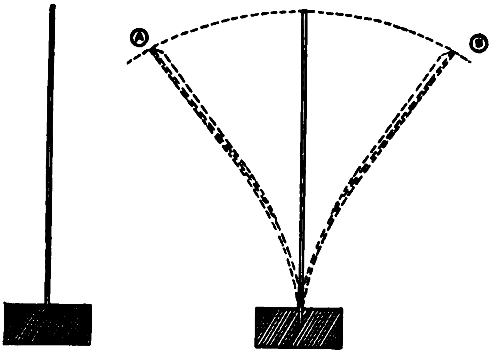


FIGURE 1. *A vibrating reed produces the most simple form of sound wave.*

And these Hertzian waves are our radio waves. The frequency of the electricity that is used to generate them lies within the ranges of 10,000 to 3,000,000 cycles a second.

We now know what a sound wave is. Did we ever notice that the seats in a theatre are invariably arranged in circles? This is done to take advantage of the fact that all waves, such as sound waves, light, heat, and radio waves travel from a point outward in ever increasing circles.

You will get some idea of how sound waves travel by observing what happens when a stone is thrown into a pool of still water. A circular wave is at once formed around the spot where the stone hits the water. This circular ripple begins to travel outwards with its diameter ever getting larger until it dies out.

If we place a cork on the surface of the water near the spot where the stone had struck, it will bob up and down violently as the wave passes by. If the cork were to be placed on the water at a distance from the same spot, the vertical movement would be much less violent because the waves would be weaker after travelling this distance.

Or take another illustration: We know that a fire built in the woods is hot on all sides and will warm people standing on one side of it just as much as it will warm those on the other side. If we move closer to the fire the heat increases because the heat waves are stronger there; if we move away, the heat decreases. This also is because the waves weaken as they travel.

The same general conditions hold true for radio waves. The transmitting station may be likened to the stone thrown into the water, and the receiving station may be likened to the corks on the surface of the water.

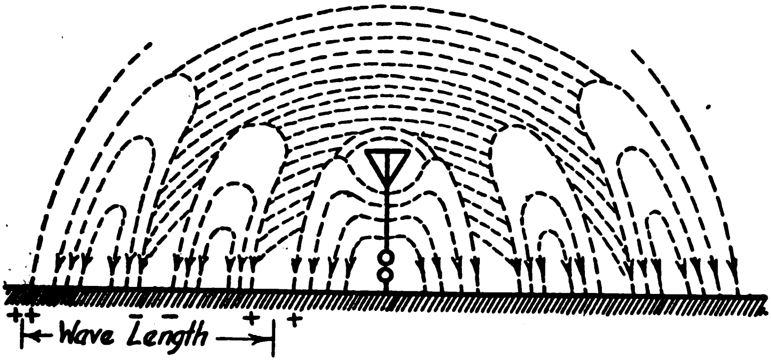


FIGURE 2; *Radio waves spread out from a transmitting antenna in much the same way as sound waves spread out from a vibrating reed. The dotted lines indicate the circular radio waves.*

HOW radio waves are sent out is illustrated in Fig. 2, which shows how they leave the antenna.

The antenna is shown, for simplicity, as a single wire vertical antenna with a spark gap as a generator of oscillations in series with the ground. For every given frequency of current jumping the gap, a wave of a certain definite length is radiated from the antenna. The length of the wave is the distance between the start and finish of one complete wave, measured along the ground. All radio waves travel with the terrific speed of light, 300,000,000 metres a second. When we know this, the wavelength of a wave radiated from an antenna can easily be calculated if we also know the frequency of the oscillations in the antenna circuit.

A table of wavelengths used for radio communication is given below as a matter of interest, showing the frequency of the currents which cause them to be emitted from an antenna:

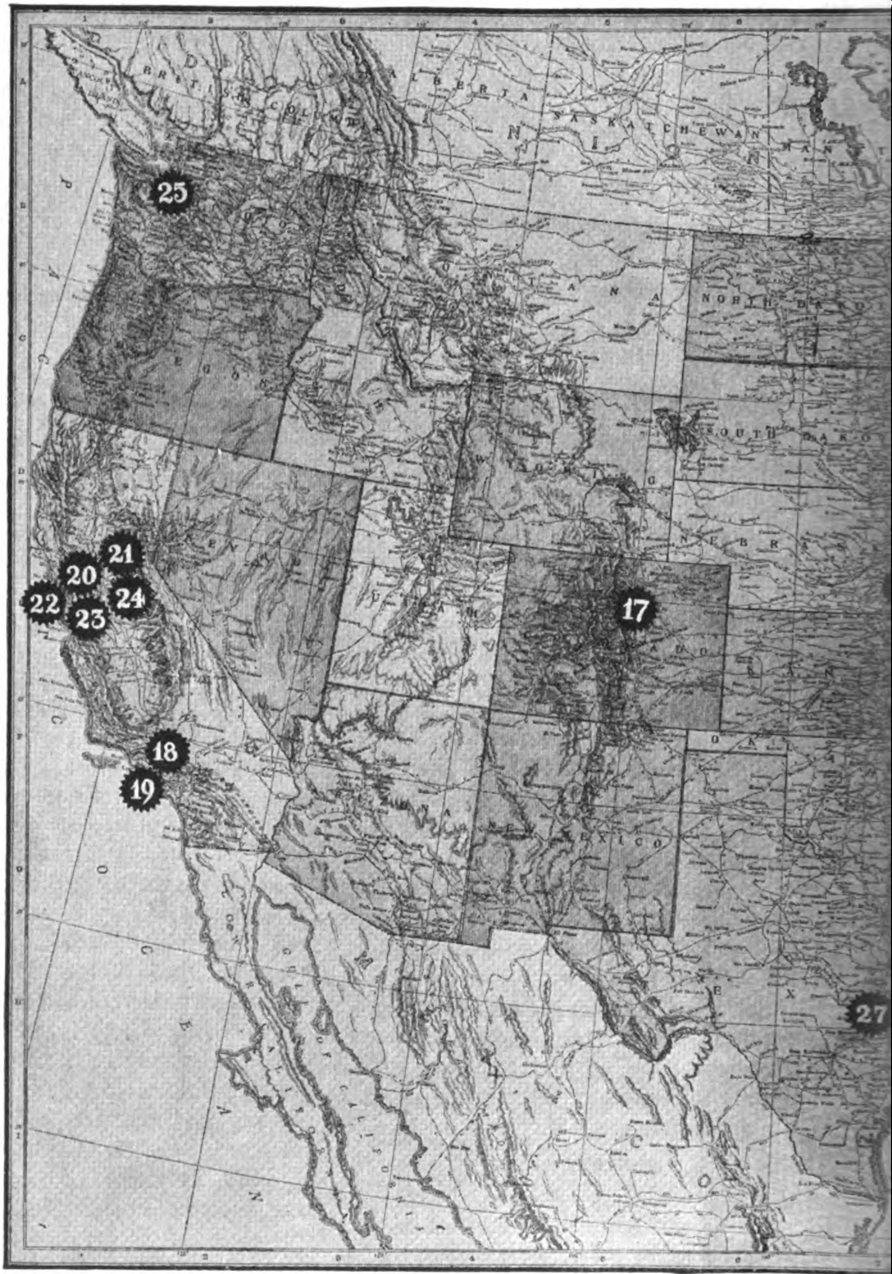
Wave length in meters	*Frequency in cycles a second*	*Type of station which uses each wavelength*
200	1,500,000	Amateur stations
300	1,000,000	Ship stations
360	834,000	Radio telephone broadcasting stations
450	667,000	Ship stations
600	500,000	Commercial ship and shore stations
1,000	300,000	U. S. Navy
1,400	214,300	Commercial traffic
2,600	115,400	Time signals
5,000	60,000	High powered commercial stations
10,000	30,000	High powered commercial stations
15,000	20,000	High powered commercial stations
20,000	15,000	High powered commercial stations
30,000	10,000	High powered commercial stations

NOW let us consider how radio waves are received.

It will be noticed from the above table that as the frequency of the current in the antenna decreases, the length of the emitted wave increases.

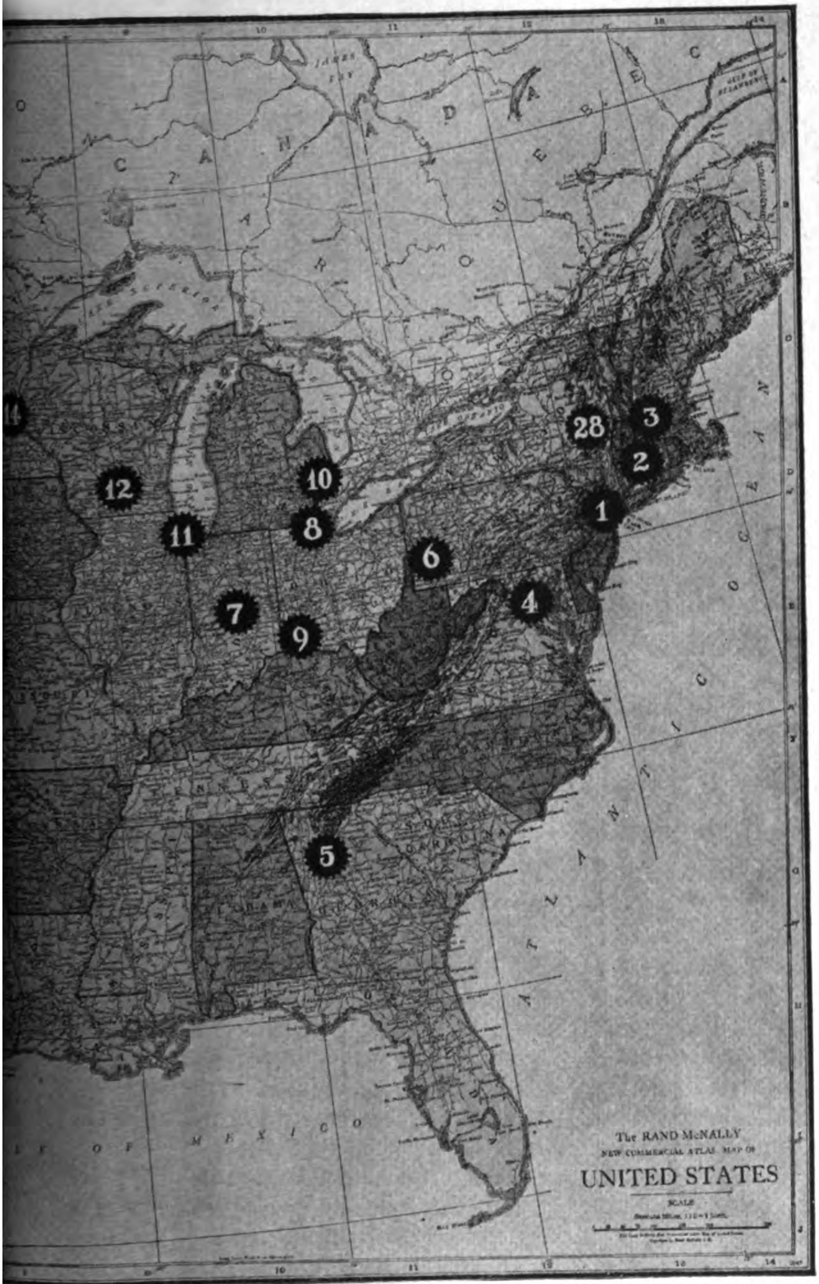
We receive a radio wave when we erect an antenna with its insulated wires high in the air, and these wires get in the way of the advancing circular waves. When a series of waves strike the antenna they do not cause it to bob up and down like a cork, but they do produce a tangible result nevertheless. This result takes the shape of a feeble current induced in the receiving antenna which is an exact replica of the current in the transmitting antenna, but reproduced on a much smaller scale. It has the same frequency and is like it in every respect except in strength.

Thus we can readily see that it is not the electric current itself that travels through the ether, but that the electric current does start a disturbance in the ether in the form of a Hertzian wave which travels outwards in all directions in circles. And when these waves strike another antenna which is tuned to that particular wavelength, they will induce in that antenna a current similar to the transmitting current, only of decreased intensity.



PRINCIPAL BROADCASTING STATIONS OF THE UNITED STATES

No.	STATION	STATE	CALL LETTERS	CONTROLLED BY
1	Newark	N. J.	W J Z	Westinghouse Co.
	Jersey City	N. J.	W N O	Wireless Telephone Co.
	New York	N. Y.	W D T	Ship Owners Radio Service
2	Hartford	Conn.	W Q B	C. D. Tuska Co.
3	Springfield	Mass.	W B Z	Westinghouse Co.
4	Washington	D. C.	W D N	Church of the Covenant
5	Atlanta	Ga.	4 C D	Carter Electric Co.
6	Pittsburgh	Pa.	K D K A	Westinghouse Co.
7	Indianapolis	Ind.	W L K	Hamilton Manufacturing Co.
8	Toledo	Ohio.	W D Z	Marshal Gerken Co.
9	Cincinnati	Ohio.	W M H	Precision Equipment Co.
10	Detroit	Mich.	W B L	Detroit News
11	Chicago	Ill.	K W Y	Westinghouse Co.
12	Madison	Wis.	W H A	University of Wisconsin



No.	STATION	STATE	CALL LETTERS	CONTROLLED BY
13	Omaha	Neb.	W O U	R. B. Howell
14	Minneapolis	Minn.	W L B	University of Minnesota
15	Kansas City	Mo.	W O Q	Western Radio Co.
16	Lincoln	Neb.	9 Y Y	State University
17	Denver	Col.	9 Z A F	Reynolds Radio Co.
18	Pasadena	Calif.	K L B	J. J. Dunn & Co.
19	Los Angeles	Calif.	K Z C	Western Radio Electric Co.
20	Oakland	Calif.	K Z Y	A. and P. Radio Supply
21	Sacramento	Calif.	K V Q	J. C. Holbrecht
22	San Francisco	Calif.	K D N	Leo J. Meyberg Co.
23	San Jose	Calif.	K Q W	Chas. D. Herrold
24	Stockton	Calif.	K W G	Portable Wireless Telephone Co.
25	Seattle	Wash.	K F C	Northern Radio Electric Co.
26	Dallas	Tex.	W R R	Police Department
27	Austin	Tex.	5 Z U	State University
28	Schenectady	N. Y.	W G Y	General Electric Co.

"I just talked on with no encouragement, no applause, no dissent. And when I finished—silence. I was awed."

Photo by J. Feder

Miss Wells Is Believed to Be the First Woman to Lecture Professionally by Radio.

"How It Feels to Talk *to* 1,000,000 People"

Perhaps YOU *Were One of the Silent Listeners-In on This First Radio Talk on Fashions by—*

MARGERY WELLS

"WE want you to speak into the radiophone," said a sober enough looking editor. I tried to appear intelligent. I was willing to try anything once. But as a matter of fact, I hadn't the faintest idea what a radiophone was. I could only pray that the forthcoming "conference" about it (it seemed imminent) would elucidate matters for my bewildered brain.

But the veils of mystery thickened as he trustingly went on to say: "You see, instead of putting you in print, we will put you in the air."

I felt as though I had suddenly been transported to Mars to be confronted with new principles of life. How could *I* be put into the air?

First of all, I wanted to know what it was like, so I asked if I could listen to a radiophone. Whereupon I was ushered into a room where a plain enough looking box and a set of telephone ear pieces were placed upon a table. I put the receivers to my ears and heard a strange click-click-click.

"That's the code," I was told.

"Oh, the code, of course," I repeated vaguely. For half an hour I listened to clicks. I was informed that "they weren't sending any speeches out just now."

Finally the editor told me to go home and write a little speech—just an ordinary little speech. Then on Saturday I could go to Newark to "put it in the air."

"To talk to a million people"—that's what the editor said I would be doing.

At least there would be some thrill of contact with other personalities. But in the dark of the evening I reached the transmitting station, only to find it isolated and alone.

I might have known, but I didn't.

In a small, narrow room, huddled in one corner, sat the members of a jazz band, waiting to play their piece. A young man greeted me, turned tail, approached a large, round disc situated somewhere near the saxophone and solemnly said—to nothing whatever, it seemed to me:

"Miss Wells has now arrived. After one selection from the orchestra, Miss Wells will speak."

I found the only available seat—a golden oak table—to support me in my astonishment. And while I listened to the musical performance I could only think that, as least, this was a fitting introduction. . . .

The music stopped. There was a pause. Then I heard the announcer stating into his circular instrument:

"Miss Wells will now . . ."

I wanted to flee. How could I be so absurd as to stand there in the center of an almost empty and silent room and speak about fashions, without one single glance of encouragement, without even one single slumbering personality to inspire me to wake it to life?

I walked up to this new adventure in life, fired at the last minute by the thought that here, at least, was my chance to be the most modern kind of an individual. What could be more lonely and vacant, I ask you, than a speech at night in the middle of the room where during the day the clerks of a business concern hung their hats and coats?

My voice trembled. A thrill shot through me. I was awed. At the empty coat hangers? No! At the vastness, of the newness of the experience—at the sensation of participating in the latest achievement of science.

I started off with my speech. I heard a voice at my ear telling me to talk more slowly. I cut down the speed. And that was all. I just talked on and on into utter silence with no encouragement, no discouragement, no applause, no dissent. Just a vast vacant silence. And when I finished—silence. The leader of the jazz band announced that he would play an encore. (No one had asked for it; how could he?) I sat down again on the edge of the golden oak table, and the announcer smiled patronizingly in my direction and said, "I think it got over very well."

After a while I found courage to ask an expert how far my voice had carried. He eliminated all of my remaining equilibrium by answering:

"They probably heard you in Scotland tonight."

* * * *

Now I listen to other speeches regularly. From their voices I am learning much. I find that I am thinking differently about being a radiophoner. I realize to "get over" I must be totally sincere. Only a realism of tone will transmit itself to the wires. I hear professional speakers talk over the radio and I cannot help but feel that their best grandstand plays are failing to reach the audience. They cannot depend upon mere stage presence or gestures. I hear a plain, everyday little clerk make an announcement and I am struck with the conviction which his voice carries with it. I am impressed with the fact that this is a new art, bringing into relief a whole new set of values. And like many other forms of modern art, it is the inner intention that carries conviction. It is a new art in which the mere external "front" doesn't register. To get over, the radiophoner must, first and last, be sincere.

I can understand now how the radiophone is developing an entirely new type of public performer.

ADVENTURE IN THE AIR

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from* 50 *to* 300 *words in length, the Editor will pay upon acceptance. Address contributions to Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East* 40*th Street, New York City.*

My First S O S Call

TO hear a call for help and to participate in a rescue is ever the high-water mark of adventure—and of service—that spurs the radio operator's ambitions. If the explanation offered in the writer's last paragraph is correct, the Editor can only agree that some one perpetrated a trick several fathoms low.

A commercial radio operator on his first trip to sea starts out with a feeling of responsibility that gradually wears off as day after day and week after week passes by without a thrill. Before we entered the war I knew many operators who had been several years at sea without so much as hearing a single distress call.

My own first assignment was on one of the few ship stations that was then equipped with an arc transmitter. The first operator had gone below to turn in, after showing me how to work the controls. The ship had passed Ambrose Light into a rather stormy sea and the air was full of radio traffic of the busy harbor. To pass away the time I began to familiarize myself with the equipment by "tuning in" various stations.

I had been on watch about ten minutes when I was suddenly startled by the strong signal:

"S O S, S O S, S O S."

It was piped in a shrill key; from the strength of the signal, I concluded the ship must be close by. The signals stopped without any signature to reveal the identity of the sender.

I replied at once with a "QRA?" (meaning, "What ship is that?") and signed my call briefly. On listening in again, I found the air full of calls; all the stations and ships in the harbor were responding in an effort to locate the vessel. After half a minute there was silence again.

The S O S was repeated several times. I recognized the characteristic note of a German Telefunken quenched gap transmitter. But there was no signature. For several hours the Navy Yard station, revenue cutters and coast stations tried to learn the identity of the ship, but no reply was received and my visions of assisting in a thrilling rescue as my debut into commercial radio gradually vanished.

The source of the message was never traced, but not many weeks later our coast was visited by German submarines. The consensus among shipping men was that we were the victims of a practical joke on the part of the operator on one of the submarines that was making a trial trip prior to the visit of the U-53 at Newport.

EDGAR H. FELIX

A Well-Preserved Old Passenger

IF the following adventure has been sent in by anyone with a less extensive experience as a radio operator at sea than the writer is known to have had, the Editor might have concluded that it emanated from the substance on which the point of the story is based.

It was the first voyage I had ever made South, and I wasn't quite used to the static interference that causes so much trouble for radio in those waters. We were on our way to Porto Rico, when we passed the passenger ship *Philadelphia* on her way back to New York. Among her distinguished passengers was an eminent citizen of San Juan, who had been in bad health and was on his way to see a specialist in New York. He passed away while the ship was at sea, however, and the operator on the *Philadelphia* called upon me to relay certain traffic for him to and from San Juan, as he could no longer work through direct, being out of range.

I passed the first message along all right—requesting relatives to advise concerning disposal of the late passenger's remains. I got into hot water, however, when I relayed the reply to the inquiry. The static had started up pretty bad and burst after burst filled the air with such a racket that it was almost impossible for me to read the message that the big station at San Juan was sending me. I struggled with it bravely, and finally got all but part of one word. Even though I had the operator repeat it several times, as luck would have it a burst of static would always drown out that one word, along with a few others. Finally I evolved this:

"Funeral in New York. Preserve Body in —ine."

This incomplete line brought up visions of my school days, when I was regaled with glass bottles containing snakes and other creatures preserved in alcohol. It occurred to me, therefore, that the mutilated word must be WINE, which in those days had plenty of good alcohol in its composition. So, jumping at this conclusion, I gave an O. K. for the message and passed it along. As a result, the late passenger finished his journey in a state of splendor seldom enjoyed these days except beyond the three-mile limit.

It later developed—when I was called on the carpet to explain my message—that the word should have been "brine."

DAVID LAY

Curing a Patient by Radio

UNTIL a device is invented that will enable the doctor to look at the patient's tongue and feel his pulse—and collect his bill—by radio, professional calls like the following will have to be charged up to profit and loss:

Dr. Maeth, who was Chief Surgeon, the Second Mate and Smith, one of my assistants, had finally prevailed upon me to join them in a little game of poker. There was very little doing in the air at the time, so I accepted—keeping the 'phones on my ears so that I wouldn't miss anything of importance.

The old *Susquehanna* was rolling over on her beam ends and the wintry Nor'wester was humming a tune through the rigging overhead. We were a week out and had another week yet to go. Coal was poor, weather bad and we were making slow going of it across the North Atlantic on our way to Bremen.

Maeth won the first two pots and was dealing the third hand when I heard some ship start right off with a "QST." I began to forget the game and copied what he was saying. The message ran:

"Any ship around which has a doctor on board please answer."

He signed off *"GKL."*

Automatically I touched the button which started up my motor-generator, and answered him:

"GKL DE KOLN. This is the SS. Susquehanna. We have two doctors. What can we do for you?"

Promptly he replied:

"SS. Hartlepool; Chief Engineer seriously ill, now unconscious, temperature 103; *had severe stomach pains."*

"Stand by," I flashed him, and I turned to the doctor. "Here's a case for you," I said as I passed him the yellow scratch paper with the message pencilled across it. His brow knitted.

"Find out what he's been eating," he suggested.

"Canned salmon," came the answer. *"Gave us all indigestion."*

"Sounds like ptomaine poisoning," said Maeth, as he wrote something on the back of the paper I handed him. "Here, send them these directions."

It was less than an hour afterward when the *Hartlepool* called me again.

"Patient greatly relieved and resting quietly. Very grateful."

"Doc," said the Second Mate, "your practice takes you all over the North Atlantic, but when are you going to collect your bill for services rendered like that?"

"That's all right; he collects from me," I said, as I pushed across a fat pile of chips, just as I had done before several times during the evening.

E. JAY QUINBY

An Unintentional Broadcast

ONE of the dangers of carrying on a radio conversation—and a danger that every operator overlooks at least once in his experience—is that of being overheard. No one who communicates by the air route can know just how many eavesdroppers are listening in on him.

When I first installed my set in my house in Jersey I gradually began to get acquainted with the other amateurs in my neighborhood whose instruments came within range of mine. In the course of a few weeks I could recognize the "voices" of the different transmitters, and pick out from the medley of communications in the air the distinguishing sounds of the various "sets." In this way I picked up a radio acquaintance with 2AKO, who lived a few miles away, and with whom I began to exchange the usual amateur's greetings. As the radio acquaintance grew we expressed the mutual desire to meet personally, and 2AKO invited me to drop in—offering as a bribe some refreshments that included a drop or two of liquid that he had been guarding since pre-Volstead days for special occasions.

Plans for the party were described in detail by radio, the exact location of the house was specified, as well as the methods of reaching it, and a day and hour was set. Indeed, we anticipated every detail except one; we did not realize how many amateurs were listening in on our plans.

On the night of the party seventeen uninvited but interested amateurs showed up!

WILLIAM A. MACKAY

A Radio Message That Saved My General

EVERY man who served in the famous Radio Section of the A. E. F. met with enough adventure to fill a book. Here is one that comes from a former officer of the Signal Corps:

One of the most exciting of my experiences as Division Radio Officer of the Eighth Division occurred in the St. Mihiel sector, when a radio message saved the Division Headquarters and staff from instant death.

Our second day's advance found the Division Headquarters established in an old church in the town of Bouillonville. This town had been vacated only that morning by the Germans, who had been there for the past four years; consequently it was well fortified with dug-outs and bomb-proof shelters. I had the Division radio station established in what was left of an old German battalion headquarters' dug-out, under the brow of a hill facing a small creek.

Fritz had been throwing high explosives over all day, but they did little damage, as our aero squadron had been so active in keeping the German fire control plane away that the enemy could not determine the effectiveness of his fire.

Orders had just been received covering the objective for the next day. I took my map and a copy of the field orders to the radio office to plan out the movements of my radio company, as we had two electric lights there. I had just entered the dug-out when the radio operator on duty remarked:

"Captain, have you noticed that those shells are coming closer and closer each time?"

"No," I answered.

"Would the captain listen in and see what he makes out of this German plane, which has been sending the same code letters over and over for the last ten minutes?" he inquired.

I took the receivers. I heard the German fire-control plane sending "XZ8945" over after each shell exploded. It came to me like a flash that he was giving out coordinates or in some way directing the big gun. I copied the code and hastened to the Chief of Staff and told him my theory. While I was talking with him the General came out of the hole where he was trying to get some sleep. When I had explained my suspicions he exclaimed:

"By George, I believe you are right."

He immediately issued orders for every man to seek the large bomb-proof shelter under the church.

It was probably twenty minutes afterward when Fritz planted a shell fair and square through the room where the Division Staff had been.

The General was profuse in his thanks. And well he might have been, for the wireless had saved his life.

CAPT. C. O. VAN DER VORT

"73"

FEW tales of shipwreck carry with them the spirit of that indomitable heroism that laughs at death as does the true story of the sinking early in March of the little Norwegian freighter *Grontoft*, with twenty-eight men aboard, including "a gallant wireless operator, name unknown." The New York *Tribune* thus reports his passing:

Until 10 a. m. March 2, he was an undistinguished member of that adventurous company of youths who perch on heaving hurricane decks the world around with receivers clamped to their heads, while their jests and gossip ride the ether waves. His body, with those of the nineteen others aboard the Grontoft, has an unmarked grave about 700 miles off Cape Race, but while the wireless bears tidings of tragedy and heroism across the seas his name will be remembered by the craft and the manner of his death.

One of the fiercest gales of a ferocious winter was lashing the Atlantic, burying mighty liners beneath mountains of water. The *Esthonia* was laboring westward toward Cape Race, still 700 miles away. At 10 a. m. Edward Hanson, braced at his table in the wireless operator's quarters, caught an S O S.

It was from the *Grontoft,* bound from Norfolk to Esbjerg, now unmanageable and at the mercy of the storm. The call for help was sent in stereotyped form and included, as regulations require, the position of the *Grontoft,* which was forty-eight miles northeast of the *Esthonia,* almost in the wind's eye.

When he reached the end of the form message the *Grontoft's* operator kept right on talking, however, starting a series of Homeric pleasantries which may still be dimpling the ether of interstellar space with their ripples.

"God pity the boys at sea such a night as this," quoth the dauntless operator of the floundering freighter. "The old man thinks it might breeze up by night."

He paused, and above the gale the ether pulsated to the swift response of Hanson that the message had been received. Hanson flung the receiver on the table and notified Captain Hans Jorgenson of the S O S. The Cunard-Anchor liner *Cameronia* also had picked it up, but the *Cameronia* was 200 miles away and had just been swept from bow to stern by the biggest wave its skipper, Captain Blakie, had seen in thirty-five years at sea. He said, when his ship got in that it was forty feet high and about 300 feet from slope to slope.

It was up to the *Esthonia,* and Captain Jorgenson did not hesitate, although it seemed a sheer impossibility to come about in such a storm.

"Tell him that we are on the way to help him," said Captain Jorgenson to Hanson.

The operator did so. At the rate the *Esthonia* had been traveling, it should reach the vicinity of the *Grontoft* about 4 p. m., but four miles was all the staggering steamship could make in the first hour on the new course. The engines were driving ahead under forced draft, but the wind and waves exerted tremendous pressure and at intervals the screw was hoisted clear of the water while the vessel trembled and lost headway.

Another S O S was received from the *Grontoft* at 11 o'clock. When he had sent it, the freighter's wireless operator remarked to the universe:

"Well, the steward is making sandwiches for the lifeboats. Looks like we were going on a picnic."

This is in the face of a storm in which no small boat could survive five minutes, even if it reached the water right side up!

The *Esthonia* drove on at a better pace now and Hanson sent an encouraging message to the operator of the *Grontoft.* At 11:30 the skipper of that doomed vessel having other things than the wireless to occupy his mind, his operator took up the conversation on his own hook.

"The old wagon has a list like a rundown heel," he confided to Hanson with the utmost cheerfulness. "This is no weather to be out without an umbrella."

"Hold on; we'll be alongside soon," was the rejoinder of Hanson, who was unable to view the situation with the equanimity of his conferee.

Silence settled down in the ether except for occasional mutterings from far-off operators, who gave astounding statistics as to the height and breadth of waves they had observed and wanted Hanson to tell them what his square-headed skipper thought he could do in such a sea if he did find the *Grontoft.*

Hanson was in no mood for such comments, and made no answer. He was waiting for the next message from the blithe lad on the upper deck of the *Grontoft.* It came at 12.10, dictated by the captain of the freighter.

"We are sinking stern first," it ran. "The decks are wash. The boats are smashed. Can't hold out any longer."

The man who sent it seemed to feel that it was slightly out of tune. He wished to make it clear that it was the skipper's message, not his.

"The skipper dictated that," said he to Hanson. "He ought to know."

"Where did I put my hat? Sorry we couldn't wait for you. Pressing business elsewhere. Skoal!"

That was the end. The operator, alone in his deckhouse, and his fellows, clinging to the rails or the derrick mast, at the wheel or fleeing from the flooded depths of the engine room, went to the pressing business—elsewhere.

WILL WE TALK TO THE DEAD BY RADIO?

Will science find a way to open a line of communication with the Other World? To find the answer to these questions, Dr. Hereward Carrington, the famous investigator of psychic phenomena, is conducting a remarkable series of experiments. He will describe the nature and purpose of these investigations in a two-part article, beginning in the next number of POPULAR RADIO—*June.*

WHAT READERS ASK

This *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* The Technical Editor.

Question: What is the meaning of the "73" that I hear the amateurs signal to each other just before they finish their conversations on their small wireless telephones? It has always been a mystery to me.

R. N. Jenkins

Answer: The signal "73" is an abbreviation which is a remnant of the old Morse telegraph days; it stands for "best regards." The amateurs still use it.

Question: The owner of my house has refused to let me put up an aerial on the property but I have an attic 25 feet by 40 feet and I am wondering if I would get any results if I put up an indoor aerial in it. I am only five miles from one of the large broadcasting stations and that is all I care about hearing.

E. A. S.

Answer: You should expect to have very fair results with an indoor antenna constructed as suggested below, provided you use an audion receiver.

Run your antenna lead in up through the house from the place where your instruments are to be set. Starting from the floor of the attic, run the antenna wire spirally up around the walls and tack on to the wooden rafters of the walls and roof until about 200 feet of wire has been strung up. Use the water pipe for a ground and you will hear the broadcasting stations distinctly at the distance you specify.

Question: Will I be able to hear Pittsburgh from New York with a fifteen dollar receiving set?

R. B. Bergman

Answer: No. If you wish to hear Pittsburgh from New York City you will have to obtain a more sensitive receiver than can be purchased for the price you mention. Such a set would cost you at least $150, complete.

Question: Which is the more efficient, a two slide tuner or a loose coupler?

Jos. Taylor

Answer: The loose coupler will be more selective than the tuner but there are newer types of tuning instruments on the market that are better than the loose coupler. One type is known as the variocoupler, and has only two adjustments to make, as against three with the loose coupler. It is also much more selective than the loose coupler.

Question: What is the law governing the licensing of amateur wireless stations? I want to erect a receiving set to hear the wireless telephone broadcasting that I understand is being done so extensively.

Thos. Dunn

Answer: The Department of Commerce requires all individuals who own their own sending sets to be licensed; this means that an amateur who wants to operate a transmitting station must first get an operator's license. To obtain this he is required to take an examination in radio theory and be able to transmit and receive messages at the rate of ten words a minute in the Continental Morse code. This examination is conducted by the radio inspector for the district.

After obtaining the operator's license, station license blanks will be sent to the applicant to fill out. On these the applicant must outline the general plan of his station and size of his antenna, the power used for transmitting and other details; if the apparatus is such as to conform with the limitations of the government in regard to sharpness of emitted wave, power and other considerations, the radio inspector will issue a station license, and government station call letters will then be assigned to the station for the owner's private use. This call is then entered in the government call book under the owner's name.

No license is required where the station is to be erected for receiving purposes only.

Question: Will I be able to receive with a loop antenna with a crystal detector set?

M. Tibben

Answer: No. You will require two or three stages of amplification in order to increase the weak signals that are received when using a loop antenna.

Question: Will you give me a hook-up for a receiving set that employs honeycomb coils, which will enable me to receive the European high powered stations. What size honeycomb coils will be the best to use?

Answer: The diagram, Figure 1, answers your first question. A and G are the antenna and ground; L1 and L2 are honeycomb coils, size L-750; L3 is a larger honeycomb coil, size L-1000, which is used for the tickler. C1 and C2 are rotary variable air condensers of .001 microfarads capacity, and C3 is a fixed grid condenser of .0005 microfarads capacity. R1 is a one megohm grid leak resistance which is connected in parallel with the condenser C3. R2 is a 5 ohm rheostat, for adjusting filament current.

To operate the set, first adjust the filament to proper brilliancy, then place the three honeycomb coils in as close inductive relation as possible. Adjust C1 to maximum capacity and vary C2 until the desired signals are picked up. The signal can then be increased to maximum intensity by slowly varying the coupling between coils and by retuning with condensers C1 and C2.

This circuit is known as the three-coil tickler feed back circuit, and with it it is possible to hear distinctly the foreign high-powered stations at a distance of 5000 miles, if a good antenna is used.

Question: I am situated midway between two broadcasting stations to which I listen every evening. When these two stations are both transmitting music I hear an extremely high-pitched whistle going continuously; when either of them stops the whistle ceases. Both stations are listed in the newspapers as transmitting on a wave length of 360 meters. Is there something wrong with my receiver or is this some unexplained electrical phenomena?

Answer: This effect has been reported by many listeners to broadcasting stations that transmit on approximately the same wave lengths. The trouble is not in your receiving set. All modern broadcasting stations now use the vacuum tube oscillator for generating the extremely high frequency currents that are used in radio telephony. The frequency of these currents lies above the frequency that the human ear can detect; that is why we hear nothing when the music stops although the radio wave is still being sent out. When two stations are generating two sets of currents of nearly the same frequency, the two currents interfere with each other and produce the peculiar whistle that you hear in the receivers. At present there has been suggested no remedy for this phenomenon except to change the wave length of one of the transmitting stations.

Question: I have a one-half kilowatt spark transmitter with a rotary gap; my aerial consists of four wires 90 feet long with a space of 2 feet between the wires, and a lead in 60 feet long. I have been told that my wave length is over 250 meters. I have tried every way that I could think of to cut down my wave

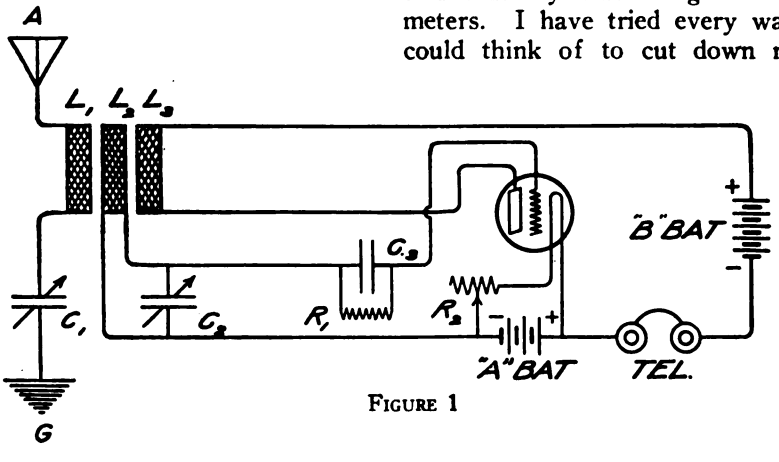


Figure 1

length to 200 metres, but cannot do so. Will you advise me?

Answer: There are two ways for you to cut down your wave length.

First: Decrease the size of your antenna to 60 feet by cutting off 30 feet on the farthest end from the lead in. This will cut your wave down to the required wave length of 200 metres. This is the more efficient method.

Second: If you do not want to change your present antenna you may insert a glass plate condenser in series with your ground lead. The condenser may be made by coating a piece of ordinary window glass, 8 inches square, with two pieces of tinfoil, six inches square, one on each side of the glass. This will leave a border of uncovered glass one inch in width around the edges of the plate. The pieces of tinfoil should be connected, one to the antenna and the other to the ground lead.

Question: I have a Baldwin vario-coupler and two variometers, and I would like to get the best circuit to use them with an audion detector. How can I do it?

J. Gerstedt

Answer: The diagram of connections is given in Figure 2. This circuit is very efficient, and will give you good results for radio telephone reception.

Question: What size of aerial should I use to receive the music sent out from such a broadcasting station as that at Newark? What size of wire should I use?

L. T. Newton

Answer: You will get the best results if you string a single wire antenna with a horizontal length of 100 feet, as high as possible and free from obstruction, from the direction you wish to receive. A No. 14 bare copper wire will be sufficient. Of course the antenna should be strung on insulators.

Question: Will a pair of telephone receivers like those used by the telephone linemen work on a wireless set? I have received telegraphic signals with them faintly, but can get no telephone signals. My set is a home-made one.

Oscar Steele

Answer: Such telephone receivers will not work efficiently as they are not sufficiently sensitive. For radio work the receivers should be of at least 2000 to 3000 ohms resistance, whereas the telephone receivers are only of 75 ohms resistance.

Question: I have just purchased for my son a complete wireless telephone sender, which was installed by an expert. Could you tell us how to keep it in running order?

Answer: Here are a few points to remember in caring for a motor-generator:

1. Keep the bearings well oiled. There are oil or grease cups on every bearing and these should be filled regularly.
2. Be sure that the brushes on the commutator fit evenly. When the brushes wear down, replace them. The end of the new brush should be shaped with a file or sandpaper to fit the curve of the commutator so that a good connection will be insured on the commutator, and no sparking will result.
3. Keep the motor-generator free from dust, grease and moisture.
4. See that all connections are kept tight.
5. Keep the commutator cleaned and polished. Start the motor and clean with fine sandpaper while the motor is running. Polish the commutator in the same manner with a piece of coarse canvas. It is well to remember not to place the hands on the generator terminals, while doing this job, as a serious shock may be sustained by the person doing so.

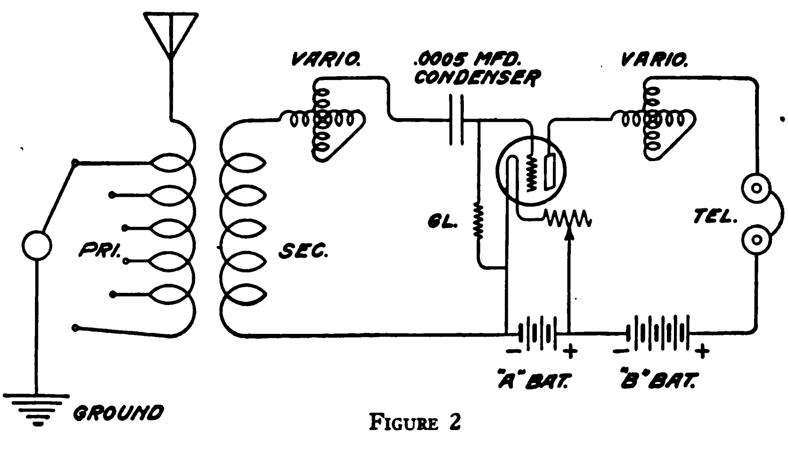


Figure 2

ITEMS *of general interest that you ought to know; bits of information of practical usefulness to every radio amateur*

What *the* Radio Conference *at* Washington Did

NOT a plaything, a novelty, or a toy, but a "new addition to our national life." As radio is springing out of youth into manhood, the tentative recommendations of the radio experts who were called into conference by Secretary of Commerce Hoover, seem to assure the public that the quoted hope of Secretary Hoover expressed at the opening of the conference will come true.

It is the public and the Government who will have first rights on the roads of the ether. In essence, the conference believes that the present laws, grown inadequate, should be changed so as to give the Government, acting through the Secretary of Commerce, practically complete control over all radio transmitting stations. There are to be practically no restrictions on the receiving end of radio. Anyone may use his ears all he wishes; those who do the talking will be strictly regulated for the benefit of the public. Radio is a public utility, say the experts. It should be controlled. And the conference has seen the ease of controlling an industry before it has gotten too old and hide-bound in its ways.

The lines of communication in the ether have been re-allotted. There are now only two officially authorized broadcasting wave lengths, 360 and 485 meters, although, of course, many more are being used. The conference has created four classes of radio broadcastings:

1. Government broadcasting by federal departments.
2. Public broadcasting by states, universities, and others disseminating informational or educational service.
3. Private broadcasting by stores, newspapers, companies and others who will distribute news, entertainment or other service.
4. Toll broadcasting by a public service radio telephone company as a paid service.

Large wave bands for broadcasting have been set aside so that the ordinary person may have the legitimate pleasure of eavesdropping on many kinds of radio telephoning. In order to do this it has been necessary to invade a large band of wavelengths formerly made sacred to military use by national law and international convention, those from 600 to 1,600 meters. Governmental broadcasting has been allotted two large wavebands, 1,050 to 1,500 meters and 1,850 to 2,050 meters, and public broadcasting allowed in the lower band. Private broadcasting, such as now sent out from Newark, Pittsburgh, Chicago and other such stations, will be permitted in a band from 310 to 435 meters, and toll broadcasting will also share this space in the ether. For a time, however, public broadcasting will be allowed in these limits.

By setting aside the waves from 275 to 285 meters for city and state public safety, the experts of the conference look forward to a time when the news of a crime, a disaster or a happier matter of civic interest will be paged throughout a city from municipal headquarters with little delay.

The wavelengths now used by ships at sea in communicating with land, those used by aircraft, the bands utilized by fixed stations in different parts of the country for commerical point to point communication, and those used by radio beacon and radio compass stations to warn vessels of danger, are not essentially changed by the conference.

Within the various bands of wavelengths, certain waves will be assigned by the Secretary of Commerce for the particular use of certain stations. However, each transmitting station is to be limited in its power so that its normal range will have an average value of: For government broadcasting, 600 miles, for public broadcasting, 250 miles, for private and toll broadcasting, 50 miles. The same wavelengths will be used again if stations are further apart than about three times their normal range. In addition to these methods of preventing interference, the hours of operation of stations may be limited in districts of congested ether, and finally there will come a time when in certain crowded parts of the country, no more transmitting stations will be allowed.

No billboards, advertisements and car-cards of the ether will be allowed. The advertising done by radio will be limited to a mere aerial nameplate. "The concert tonight is with the compliments of Smith and Brown, Station XYZ." The experts evidently believe that the ether space is too valuable to use on matter that may not interest everyone.

A new professon is seen in the radio future, that of ether policemen. Of course, the radio inspectors that we now have are the forerunners of this new brand of law majesty. The ether cop will sit contentedly listening in on the rest of the wireless world. If the transmitting stations break the ether law, the ether cop will run them down with direction finder and wave meter.

Within the band of wavelengths 150 to 275 meters, the amateur will be in control. True, the grant to him is somewhat like those given by kings of old when a group of their subjects took a new land by conquest and occupation. Not only will the amateur have this band, exclusive from 150 to 200 meters, and shared with technical and training schools from 200 to 275 meters, but the conference recommends that the amateurs do their own policing through such organizations as the American Radio Relay League and radio clubs. The band of amateur wavelengths will be divided into bands according to the method of transmission, damped wave stations being assigned the band of lowest wavelengths, interrupted or modulated continuous wave radio telegraph stations the next band, radio telephone stations the next band, and finally unmodulated continuous wave radio telegraph stations the highest band of wavelengths. It was recommended that amateurs be permitted to carry on broadcasting within the wavelengths band assigned by the Secretary of Commerce to amateur radio telephony.

In their relaying activities the amateurs will be able to span such natural barriers as mountains and lakes by special use of 310 meters.

Improvement in the science of radio is looked forward to in the report of the conference. Throughout there are provisions for adapting usage to the advances that are sure to come.

"The types of radio apparatus most effective in reducing interference should be made freely available to the public without restriction" is a major recommendation. The experts urge that the Secretary of Commerce have power to prohibit the use of existing radio transmitting apparatus and methods that result in unnecessary interference, provided that such action should not be taken unless more satisfactory apparatus and methods are commercially available at reasonable prices and until an adequate time interval is allowed for the substitution of the more satisfactory apparatus. Receiving apparatus that set up radiations that interfere would also be prohibited.

Recognizing that radio interference hampers the use of this public utility, the conference mapped a large investigative program for the Bureau of Standards. In addition to studying the relation between range and power of stations and the best geographical distribution of transmitting stations, the Bureau of Standards was asked to give special attention to:

1. The reduction of the rate of building up of oscillations in radiating systems.
2. The reduction of harmonics in continuous wave transmitters and of irregularities of oscillation.
3. The comparison of the variable amplitude method with the variable frequency method of continuous wave telegraphy.
4. The preferable methods of telephone modulation to avoid changes in the frequency of oscillation.
5. The proper circuit arrangements of regenerative receivers to avoid radiation of energy.
6. The use of highly selective receiving apparatus, including a list of approved forms.
7. The use of receiving coil aerials instead of antennas, with special reference to high selectivity.
8. The reduction of interference with radio communication of other electrical processes, such as the operation of X-ray apparatus and electrical precipitation.
9. The study and standardization of wave meters.

A vision that extends beyond our continent attended the conference. Wavelengths, from 5,000 to 6,000 meters, were set aside for future transoceanic radio telephone experiments, and the conference suggested that when the time arrived for such tests, the Secretary of Commerce should endeavor to arrange with other countries for the use of that wave band for that purpose.

The recommendations of the conference are as yet tentative. They will undergo some slight revision before they become law. They look forward to the fulfilment of Mr. Hoover's statements made at the first session of the conference:

> "We are today upon the threshold of a new means of widespread communication of intelligence that has the most profound importance from the point of view of public education and public welfare. The comparative cheapness with which receiving stations can be installed, and the fact that the genius of the American boy is equal to construction of such stations within the limits of his own savings, bid fair to make the possession of receiving sets almost universal in the American home.
>
> "The wireless telephone has one definite field, and that is for spread of certain predetermined material of public interest from central stations. This material must be limited to news, to education, to entertainment, and the communication of such commercial matters as are of importance to large groups of the community at the same time."

W. D. D.

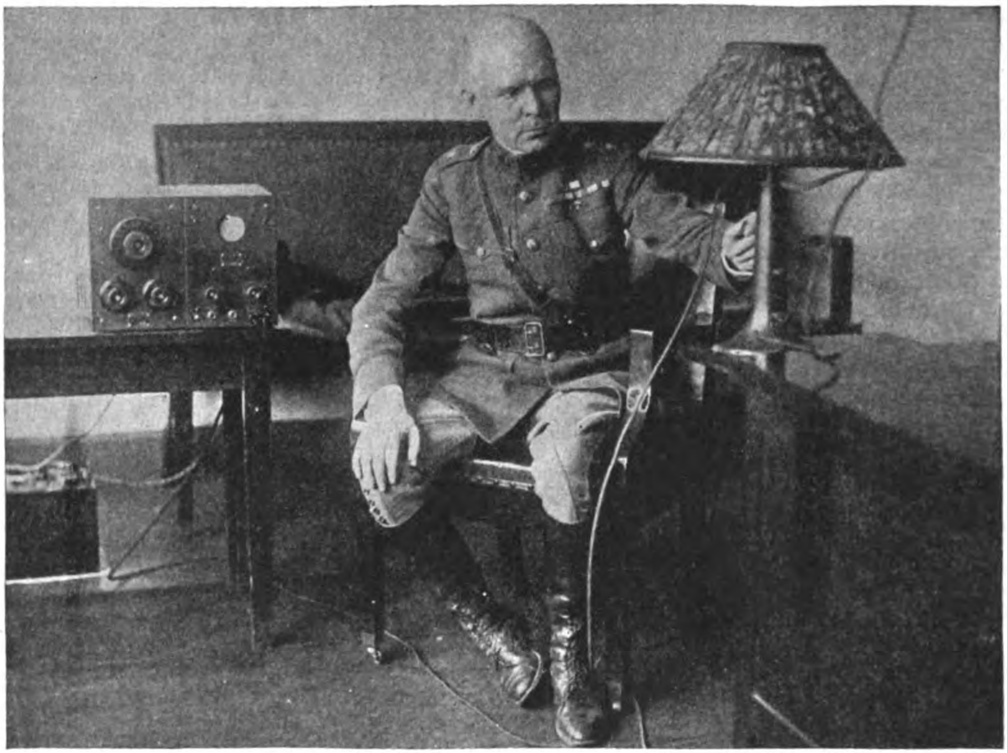
President Harding Joins *the* Radio Fans

ON the occasion of the celebration of his first anniversary in the White House the President gave two demonstrations of the keen interest with which he is watching the progress of radio telephony in this country. Early in the day he sent a communication to the Senate requesting an additional appropriation of $50,000 for an investigation by the Government in the field of wireless communications, and in the evening he attended the installation at the National Press Club in Washington of a radio telephone.

Although the President has been a member of the Press Club since he first came to Washington—in private life he is a newspaper man—and while in the Senate was accustomed to mingle there often with his colleagues of the press, the visit on the evening of March 4 was the first he had made since his inauguration.

The radio telephone at the National Press Club was installed under the direction of Mr. W. C. Horn, who explained the working of the radio telephone and gave a brief history of wireless communication. The National Press Club at Washington is said to be the first club in the United States to have a radio telephone of its own.

At the close of the demonstration the President was presented with a large frosted cake, bearing one lighted candle to mark his first Presidential anniversary.



International

AN ELECTRIC LIGHT LAMP AS AN AERIAL

Major Gen. George O. Squier demonstrates that broadcasts may be received into a room by way of the electric light circuits. But the amateur is advised to read the accompanying article before he tries this experiment himself.

Broadcasting Over Electric Light Circuits

HOW local radio telephone broadcasting may be done by means of wired wireless on an ordinary electric light circuit was demonstrated for the first time in the Office of the Chief Signal Officer of the Army on Friday, March 24, before officers of the corps, scientists and members of the press.

By this novel method the air is left clear for long distance communications. This new development in radio is believed by experts to promise a great utility by relieving the congestion in the ether due to the great number of broadcasting stations, particularly for local consumption. By purchasing an ordinary short wave radio receiving set anyone who is fortunate enough to have a direct current electric lighting system in his house is within reach of local radio entertainment.

The demonstration included the receiving of news, music, and talks from a distant room in the Munitions Building, where a radio telephone transmitter (S. C. R. 67) was connected through an ordinary socket to the lighting circuit of the building. Music from a phonograph was transmitted to the 110 volt electric line through a standard microphone such as was developed during the war for aviators.

In General Squier's office a standard Westinghouse short-wave radio receiver was connected with the lamp socket on his desk; by merely pulling the cord, the General started and stopped the music. No head pieces and no extra wiring or antenna were used, as the sound came from a loud-speaker on the wall near the set.

With receiving sets of similar type the entertainment could have been heard in any room of the large building. In a small town, or a large city with an overhead lighting system, anyone with a receiver could plug in and get the entertainment sent out by a central station.

All the work that was necessary to install the apparatus was to bring in the receiving apparatus, connect it to the ground, hang up the horn and screw an ordinary plug into the light fixture, just as an electrical flat iron is connected.

"Every home and every room in a hotel where there is an electric lamp can now keep in touch with the world," General Squier said.

There is no interference, no fading, and weather does not affect the broadcasting by this new method. The process is based upon General Squier's invention of "line radio" or "wired wireless" which he perfected some time ago and which permits the use of a line as a guide, although the messages go on wireless waves which follow the line. The turning of the switch, however, cuts the circuit and the sound ceases.

Future uses for the new invention suggest that a hotel can supply all of its guests with music from a sending station in the basement; a single orchestra can furnish music for the local playhouses and movies, and invalids at home or in nearby hospitals can get such entertainment as is furnished locally.

In the opinion of experts, this system could not be used over the large lighting cables in the city streets, as their electrical capacity is so great that it is believed it would take enormous currents at a very high wavelength to force the waves along the cables.

Amateurs are advised not to play with this new idea until they have more definite information on the subject than has been published as general news items by the daily papers, or there will continue to be "lights out" in certain radio homes.

A New Radio Fog Signal

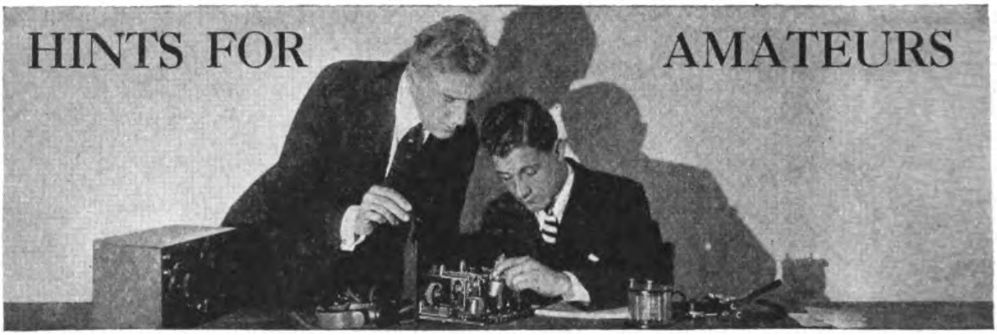
THE new lightship 105, destined for use at Diamond Shoal, off Cape Hatteras, has just passed her trials on the Hudson River. She is the largest and best-equipped light vessel in the world, according to a statement by the Lighthouse Service of the Department of Commerce, and is the first vessel of the service to carry a radio fog signaling apparatus, with the exception of the two installed on lightships off Fire Island and Ambrose Channel.

The 105 will replace the old light vessel 72, which was sunk by the guns of a German submarine on August 6, 1918. Besides a flashing light, she has three separate fog signals, a steam chime whistle, a submarine bell and the automatic radio fog signal. She is 147 feet in length over all and is a self-propelled oil burner.

The direction finding system consists of a distinctive radio signal of simple form, such as a series of dots or a combination of two dots on a 1000 meter wavelength. This signal, when picked up by a vessel, enables the master to point his radio compass in the exact direction of the signal, which he identifies, for example, as Ambrose Channel; then by picking up Sea Girt he can find his exact position by the intersection of the lines on his chart. No mathematics is necessary, and he can re-check his bearings by a third signal from another station.

By following the signal—that is, by keeping the coil aerial parallel to the direction of the signal and at its maximum sound—a due course on the point may be run. As the coil is revolved on a vertical spindle provided with a pointer, the sound diminishes, coming to a minimum when the coil is at right angles to the sound, then, with the aid of a graduated circle below the coil, the position of the coil with respect to a known direction is determined.

HINTS FOR AMATEURS



Do not use any kind of paint on your radio apparatus.

* * *

Be sure to keep the storage batteries for your radio set filled with distilled water. This will lengthen the life of your battery considerably, and keep it in good condition.

* * *

A sensitive spot on a crystal detector soon loses its sensitiveness. When your signals begin to weaken, find another spot, and when all the "spots" are worn out, buy another crystal and save yourself a whole lot of bother.

* * *

Do not place the hands on the surface of the crystal which is used for a detector. Any dirt or foreign matter on its surface will interefere with its rectifying action. Keep your crystals clean by wrapping them with a piece of tissue paper and placing in a small box until ready to use.

* * *

Do not try to "receive" during a thunder storm. Ground your antenna and sit back safe in the knowledge that a grounded antenna furnishes the best kind of lightning protection it is possible to obtain.

* * *

Do not stand your storage battery on any expensive carpets or highly polished floors. If any of the liquid should bubble out and spill over, a nice big hole will be burnt in the floor. The liquid is a solution of sulphuric acid. Place a square piece of rubber sheeting underneath the storage battery.

Do not run your antenna across the street, as you will be violating a city ordinance, and make yourself subject to a fine.

* * *

You can make a good vernier for your condensers and variometers by holding a pencil with the rubber end alongside the dial and revolving the pencil between your fingers. This will also cut down the capacity effect of your hands near the instruments.

* * *

When you see a blue glow in your tubes, it is a sure sign that you are using too much plate or "B" batteries on your tubes.

* * *

One way to use a loop antenna is to shunt the loop with a variable condenser and connect one end of the loop to the grid of the detector tube and the other end of the loop to the filament circuit. All wavelength tuning will be done with the variable condenser, and directional tuning will be accomplished by revolving the loop. At least two stages of amplification should be used to get good results.

* * *

Nearly all amateurs like to tune in signals and music as loud as possible. This is not always desirable; we should learn to tune in the music and speech for quality. When we tune in a powerful broadcasting station nearby, the signals usually are so strong that the music sounds like a thunder and lightning storm scrambled up with a barnyard scene and a jazz orchestra. If you are listening on a two step amplifier, turn down on the resistances of the three vacuum tubes a little and see what a great improvement there is in the clarity of the music. At the same time you will be increasing the life of your tubes by not burning them so brightly.

* * *

JOIN a radio club. The amateurs of all districts band themselves together for mutual benefit; this is one of the reasons why the radio art has gone forward in the leaps and bounds that we are now witnessing. If you are a beginner, find out the name of the amateur organization that is nearest to you. Then go to one of the meetings; visitors are always welcome. You will find there a friendly gathering of fans who will help you with your problems. At the meetings of such clubs, matters of importance to the beginner are explained in lectures, new developments in radio are discussed, and instruments which have been made by the members are exhibited.

* * *

ONE of the first problems that confronts the radio amateur is to construct his inductances or coils. When he comes to this stage he should bear the following pointers in mind:

He should use a material for the tube (on which the wire is to be wound), which will not absorb moisture; cardboard is not good for such use for this reason. Some amateurs coat the tube with shellac or varnish or sometimes impregnate the tube in melted parafine to make it waterproof; this removes the trouble from electrical leakage due to the presence of moisture, but it has the disadvantage of increasing the distributed capacity of the coil, which makes the set (of which the coil is a part), "tune" broadly.

The best type of material to use is known as Bakelite, Formica, Condensite-Celeron and under various other names. These substances are built up from a number of sheets of high-grade paper which have been vacuum dried and then impregnated with a synthetic resin; they are then subjected to a heating process and at the same time moulded into the desired shapes at tremendous pressure.

The wire should be wound on the tube and fastened tight by applying seals of sealing wax to the ends of the wires. This holds the winding in place without any shellac or parafine, which is so dangerous to tuning efficiency.

The best kind of wire to use is a copper wire with a silken covering.

When actually mounting the coils, keep all magnetic materials, such as iron screws and iron brackets, as far away from the coils as possible, as these materials will choke back the extremely weak high-frequency currents which have been received and are trying to pass through the coils.

* * *

TAKE great care of your telephone receivers. They are very delicate, and should be handled carefully.

Do not let anyone unscrew the caps or push his fingers into the holes from which the sound issues, as he is liable to injure the diaphram or the fine wires with which the magnets are connected inside the caps. Above all do not drop the receivers on the floor, as this will knock part of the magnetism out of the permanent magnets and thus weaken the strength of the received signals. Every knock or jolt decreases their sensitiveness.

The best way to keep the receivers is to hang them on a hook similar to a coat hook. This will prevent them being knocked off the table to the floor.

If the receivers are treated as carefully as a watch, they will last indefinitely.

* * *

A ONE wire antenna will be suitable for use for receiving. String your wire as high as possible and away from obstructions. Point the antenna in the direction that you wish to receive from for the most efficient results. The end of the antenna at which the lead-in is brought in is the pointer end and should be directed at the transmitting station you wish to listen to most regularly.

THIS *department—conducted by a patent attorney of wide experience in radio work—will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

Amplifying Apparatus

Patent No. 1,405,523: Marius C. A. Latour, Paris, France.

This invention relates to audions or vacuum tubes and to transformers associated therewith, and is so designed as to make the lamps more effective and to eliminate objectionable tube noises.

Wireless Signalling

Patent, No. 1,406,857; Raymond A. Heising, East Orange, New Jersey.

This invention relates to combined transmitting and receiving apparatus in which the antenna or aerial may be connected readily to one apparatus or the other as desired, in order to transmit or receive. The invention also includes means to eliminate side tone in the receiver when the transmitting system is being operated; that is, to prevent signals sent out by the transmitter from actuating the receiving system at the same station.

Briefly, the invention covers a transmitter that has a generator or oscillator, a receiver having means to control the side tone and a key controlled relay for connecting the transmitter and disconnecting the receiver and vice-versa, and relays for controlling the oscillator and side tone device, all operated by the key.

Radio Receiver

Patent, No. 1,407,205; Robert H. Marriott, Bremerton, Wash.

In the publication of the Institute of Radio Engineers Vol. III, No. 1, 1915, Alfred N. Goldsmith of the City College discussed stationary aperiodic frequency changers which comprise a transformer of a special design by which the frequency of a current passing through the same could be changed.

The inventor utilizes this device as an element of a combination for the purposes of eliminating static or the effects of atmospheric electrical disturbances upon a receiver.

Briefly, the invention comprises two receiving circuits, one of which is tuned to the desired wavelength or frequency, and the other of which is tuned to a frequency of one-half the desired wavelength. Owing to the aperiodic or damped character of the static impulses, both circuits receive or respond to such impulses. One circuit only, however, receives the desired signal impulses. By means of a frequency changer as above mentioned the frequency of the static oscillations or impulses in one circuit is made equal to the frequency of the static impulses in the other circuit and are opposed and neutralized, leaving only the useful or signal oscillations.

The inventor shows several forms of his device in his patent which, however, have not been illustrated owing to their technical character.

Electric Wave Ranging System

Patent No. 1,406,996; Joseph B. Morrill, St. Louis, Mo. (*See* FIGURE 1.)

This invention relates to methods and means for determining the position of an airplane or ship by means of radio. The position of any point in space may be determined by its distance from two known or fixed points. The difference of the two distances are determined in the present invention by observing the difference in time of arrival of energy, such as electric waves simultaneously transmitted from an airplane to the observing stations or vice-versa. This difference in arrival time multiplied by the velocity of the energy (which is known) gives the difference in distance. When the distance of an undetermined point from a fixed point differs from its distance from another fixed point by a definite amount, the undetermined point lies on a hyperbola which can be readily plotted with respect to the two fixed points. If another such hyperbola be determined by comparing the distance to one of these given points with that to a third given point, the intersection of the two hyperbolas determines the position of the undetermined point. The present invention, therefore, involves the transmission of electric waves of definite frequency, amplitude and phase relation to or from three fixed or known stations from or to the point to be determined, and by suitable phase adjusting means determining the differences in distance between each of the fixed stations and the point to be determined. From the data thus obtained it is possible to plot the position of the point to be determined and thus find its location.

The above apparatus and method is especially serviceable in determining the location of ships and planes at night.

The diagram illustrates one embodiment of the invention when electric wave energy is transmitted from the point to be determined. The energy received at spaced stations A B C is detected in the ordinary manner by receivers D and the low frequency detected currents are conducted from stations A B C over lines $L^3L^4L^5$ to apparatus N and receiver R. The electrical lengths of lines $L^3L^4L^5$ must be known. The several energies are then brought into phase by phase retarding or adjusting means, which indicates the difference in time arrival of the several signals and hence the differences in length of several paths.

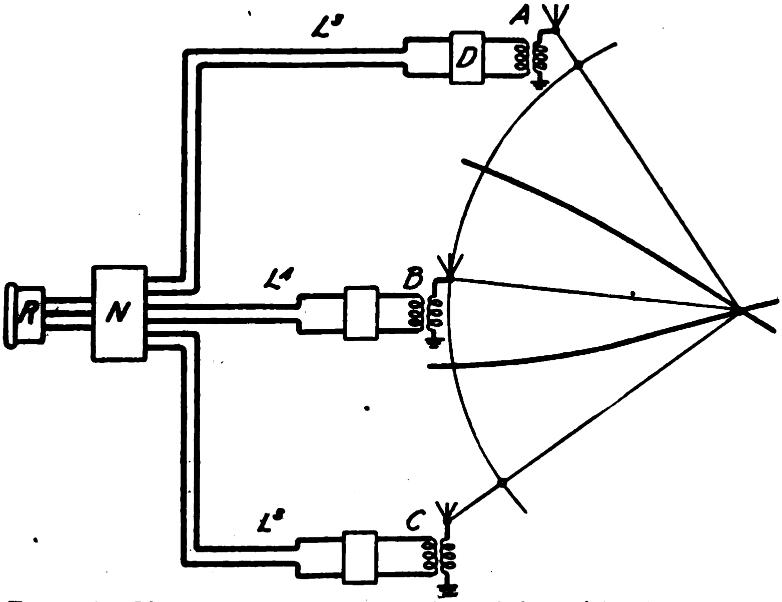


Figure 1. *Diagram illustrating the method of determining by radio the position of an airplane or ship.*

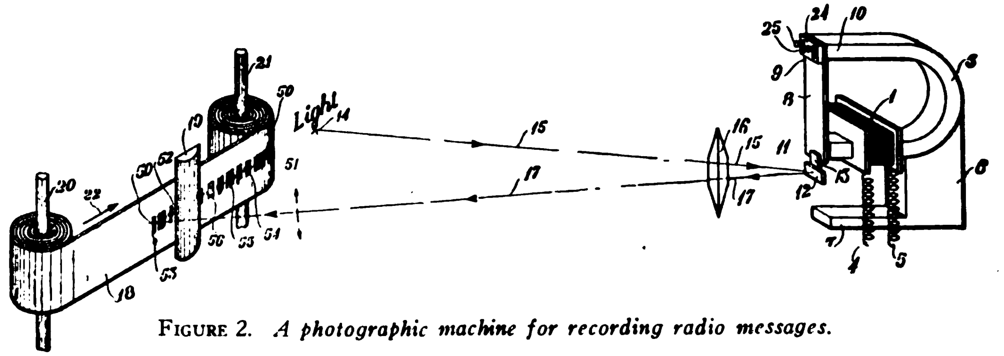


FIGURE 2. *A photographic machine for recording radio messages.*

Photographic Receiving Apparatus

Patent No. 1,406,445; Charles A. Culver, Beloit, Wis. (*See* FIGURE 2.)

This invention relates to means for recording signals received by radio.

The apparatus illustrated in the drawing may be connected to any radio receiver, in lieu of the usual telephone, by means of the leads 4 and 5 of coil 1. The device may be used with damped wave receivers or with undamped wave receivers such as the heterodyne or beat receivers for making a permanent record of the received signal.

The coil, 1, is mounted upon one pole of the permanent magnet 3. A reed, 8, is secured at one end to the other pole of magnet 3 with its free end adjacent to the pole on which coil 1 is mounted. A mirror, 12, is suspended from the free end of reed 8 by means of a flexible strip, 13, the mirror having relatively high mass or inertia compared to the force required to flex strip 13. Reed 8 is preferably of thin, highly resilient material to provide very low damping force, and at least near its lower end must comprise magnetic material. A source of light, 14, is arranged to direct an incident ray of light, 15, on to the mirror, 12, through lens 16. The reflected ray, 17, is refracted through lens 16 on to a strip of sensitive photographic paper, 18. Upon reception of signal oscillations by the receiver, the reed 8 is mechanically vibrated in correspondence with the electrical oscillations which cause a deflection of the mirror and ray, 17, due to change of magnetic flux between reed and magnet. The sensitive strip 18 is mounted on rolls which are driven by clockwork.

In order that reed 8 may be vibrated by or be in tune with the received electrical oscillations the period of the reed must be adjusted to be equal to the period of the electrical oscillations. The vibration rate of the reed is adjusted by varying its effective length by means of the clamping members, 24 and 25, and when its rate of vibration is of the order of the received electrical oscillations the reed responds to such oscillations. When beat reception is utilized the number of beats a second can be so adjusted as to be of the order of the rate of vibration of the reed.

A dot and dash record is indicated on the strip 18 in the diagram.

The inventor claims for the above device great sensitiveness by reason of the amplifying effect of the "beam of light pointer" and selectivity; that is, the device is not affected to any extent by static excitations.

Radio Receiver

Patent No. 1,405,905; Francis W. Dunmore, Washington, D. C. (*See* FIGURE 3.)

This patent is unusual in that the public—meaning anyone—is at liberty to use the invention without payment of royalty; the specification states that "the invention described and claimed herein may be used by any other person in the United States without the payment of any royalty thereon." The application for this patent was filed by a government employee under the Act of March 3, 1883, without payment of fees, the invention being thus dedicated to the public, as it is called.

The invention relates to closed loop aerials known as "direction finders" of "radio compasses" used to determine the location of a transmitter.

Such a loop differs from an open aerial or vertical antenna such as commonly used in connection with amateur and other reception in that while the open aerial will receive a signal originating from any point around the antenna, the loop receives a maximum signal when its plane lies in line with a given transmitter or at right angles to the wave front and receives not at all when arranged 90° from its position. Thus by swinging the loop until the maximum response is noted in the telephone or until the minimum response or "nul point" is noted, the direction of the distant transmitter may be accurately determined to within one or two degrees.

While the closed loop has, theoretically at least, a distinctly determinable maximum and minimum signal, nevertheless the loop, which has a vertical dimension and a capacity to ground, functions also as an open aerial or antenna; hence the combined signals received, because the loop acts both as an open and closed aerial, tend to blur or distort the maximum and minimum due to pure loop action making the apparatus less sensitive.

The closed loop requires no connection to ground in order to make it operative; it may be set up in a room, and with suitable amount of amplification, signals may be received even from European stations.

The invention of the Dunmore patent is intended to reduce the "antenna effect" and make the loop more sharply directive, that is, "to give a quieter, sharper and less distorted minimum."

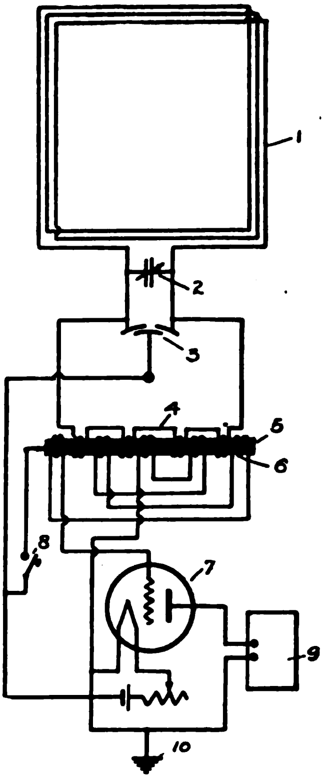


FIGURE 3. *A new type of directional loop receiver.*

For this purpose, he interposes between the loop, 1, and the audion receiver, 7, a transformer or coupling of special design. This transformer comprises a primary coil, 4, wound in one or more sections and connected across the tuning condenser, 2, which is interposed in series in the loop. The primary coil is wound on an iron core, 5, consisting of iron laminations about .001 inch thick. A secondary coil, 6, is wound in one or more sections between and alternating with the primary sections. The imput terminals of an audion detector, 7, are connected in circuit with the secondary coil. The iron core and the cathode (the heated filament) of the tube have a common ground, 10. The core, 5, serves a two-fold purpose; first, to couple the loop, 1, to the detector or audion tube and distribute the capacity effect more evenly to ground; and, second, to partially bipass to earth through the core, disturbing influences such as motor and ignition noises. It should be noted that the connection of the secondary coil to

A PAGE WITH THE PUBLISHER

WITH this number which you hold in your hand—Volume 1, Number 1,—Popular Radio makes its bow to the radio amateur.

The purpose of this magazine is two-fold:

First, to be of practical helpfulness to the amateur who owns or expects to own and maintain his own radio apparatus;

Second, to keep him informed concerning the latest and most important methods, equipment and applications of the radio art—an art that has seized the popular fancy with such amazing suddenness as to precipitate a development that promises to surpass anything in the history of science.

In the attainment of these purposes, I have obtained the services of some of the most capable radio experts and magazine makers in the country.

A glance at the preceding pages is evidence of the quality of the editorial fare with which our readers will be served.

The list of contributors to this and to the succeeding numbers is one of which any magazine, no matter how old or well established, may well be proud. It includes not only eminent scientists but world-famous writers. You know them — Hiram Percy Maxim, Nikola Tesla, Waldemar Kaempffert, Paul Godley, Dr. Henry Smith Williams, William G. Shepherd, Edwin E. Slosson, Dr. Lee De Forest, Fred C. Kelly, Homer Croy, Professor Michael Pupin, James H. Collins, Thomas A. Edison, Dr. E. E. Free, Donald Wilhelm, Will Irwin, Dr. Hereward Carrington, Edwin Bjorkman, Edwin H. Armstrong, Lincoln Steffens, T. C. Martin, Byron G. Eldred, to mention but a few.

Popular Radio will be profusely illustrated with photographs, drawings and diagrams. The world is literally being scoured for pictures that convey useful and interesting information to the radio amateur.

In pursuance of our policy to serve the radio amateur, this magazine will carry the advertising only of responsible business firms whose products are known to be dependable.

Further, (and in pursuance of this policy I must depend upon the cooperation of the radio amateur himself), this magazine will take such steps as may be necessary to prevent unscrupulous manufacturers or dealers from foisting upon the market radio equipment that is fraudulent or that is sold under misrepresentations.

Readers are not only invited, but *urged* to notify Popular Radio if any product advertised in these pages is not as represented.

In adhering to this policy, the publishers are prepared to act without fear or favor. *Popular Radio, Inc., is an independent publishing house, with no trade affiliations.*

To insure the maintenance of the high standards which the publishers have set, I have placed the editorial direction of this magazine in the hands of two men whom I here introduce to you—in case you do not already know them:

Kendall Banning, the Editor, is not only a magazine writer himself, but for several years was the Managing Editor of "System" and more recently of the "Cosmopolitan". During the war he served in the army for two years, first a major in the Signal Corps and later on the General Staff Corps—an honor attained by few reserve officers. He is now a Lieutenant-Colonel in the Signal Reserve Corps, and member of the Executive Council of the Amateur Radio Reserve of the Second Corps Area, United States Army, of which he was one of the founders.

Laurence M. Cockaday, the Technical Editor, is a member of the American Institute of Electrical Engineers, of the American Institute of Radio Engineers and of the American Association for the Advancement of Science; he is also an inventor of radio apparatus and the holder of a dozen or more patents. During the war he served the Navy as instructor in radio. He is, however, perhaps best known to the radio amateur as the owner of the famous 2 X K, one of the most active amateur stations in the country and the holder of that rare and coveted distinction—a certificate from the Department of Commerce that permits experimental work to be conducted with any apparatus on any wavelength.

Now glance through the preceding pages.

We originally intended to print 100,000 copies of this number. But when I looked over the advance proofs with our circulation manager and saw the character of the magazine, I changed my plans and we are printing 125,000 copies instead.

Do you not agree that it is a prodigal 15 cents worth?

H. B. Emerson

President, Popular Radio, Inc.

Engineering
622.05
P831

Popular Radio

JUNE 1922

15¢

vol 1
no 2

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UNNING DOWN
AW BREAKERS
BY RADIO
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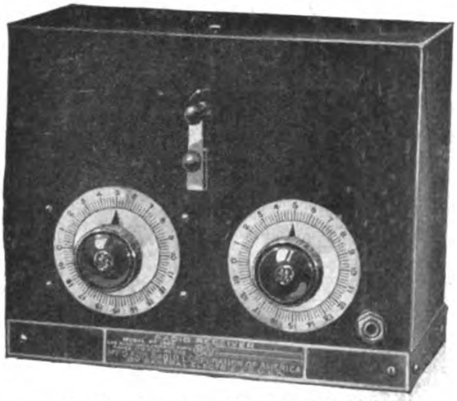
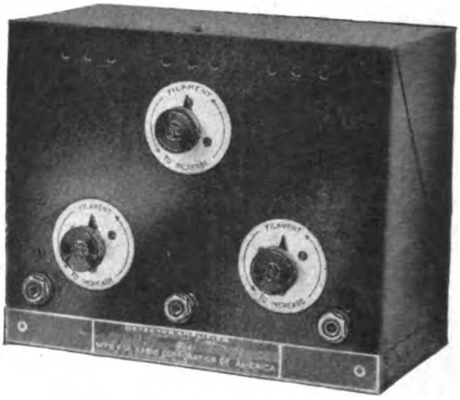
he Radio Amateur

RDERS FROM HEADQUARTERS"

Crystal or Vacuum Tube Detection with the same set



Radio Receiver Model AR-1300



Detector Amplifier Model AA-1400

These two sets (Radio Receiver Model AR-1300 and Detector Amplifier Model AA-1400) meet the demand of the novice who wishes to start with a simple crystal detector and later to pass on to vacuum tube detection and amplification at minimum cost.

Radio receiver Model AR-1300 is a new tuner for the broadcast enthusiast. Used as a crystal detector it is a complete receiver. Used with Model 1400, here shown, the crystal detector is ff and amplification is controlled by

of

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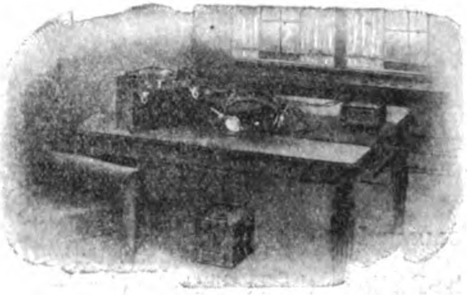

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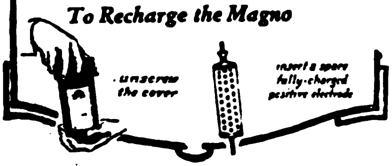
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POPULAR RADIO

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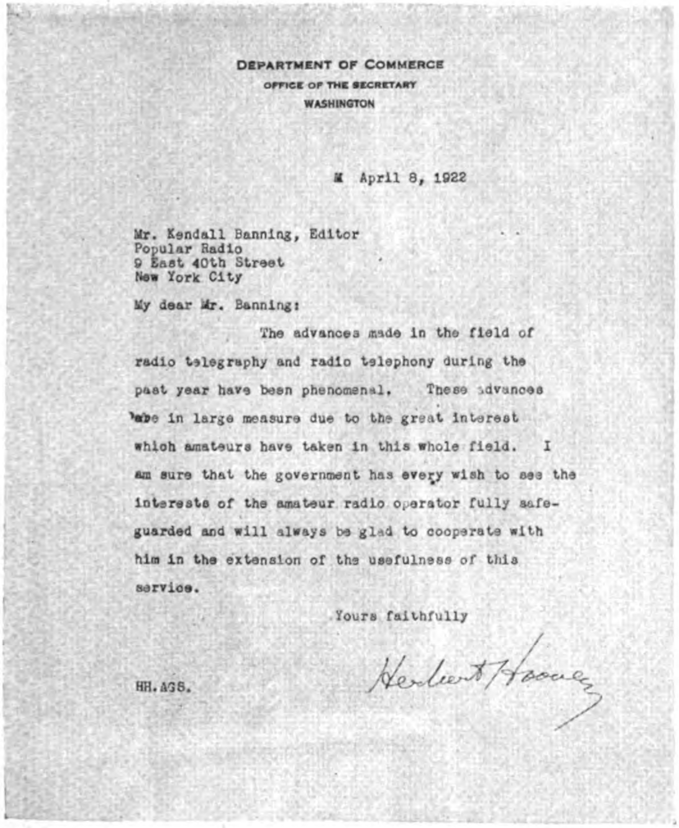
KENDALL BANNING, *Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*



DEPARTMENT OF COMMERCE
OFFICE OF THE SECRETARY
WASHINGTON

April 8, 1922

Mr. Kendall Banning, Editor
Popular Radio
9 East 40th Street
New York City

My dear Mr. Banning:

The advances made in the field of radio telegraphy and radio telephony during the past year have been phenomenal. These advances are in large measure due to the great interest which amateurs have taken in this whole field. I am sure that the government has every wish to see the interests of the amateur radio operator fully safeguarded and will always be glad to cooperate with him in the extension of the usefulness of this service.

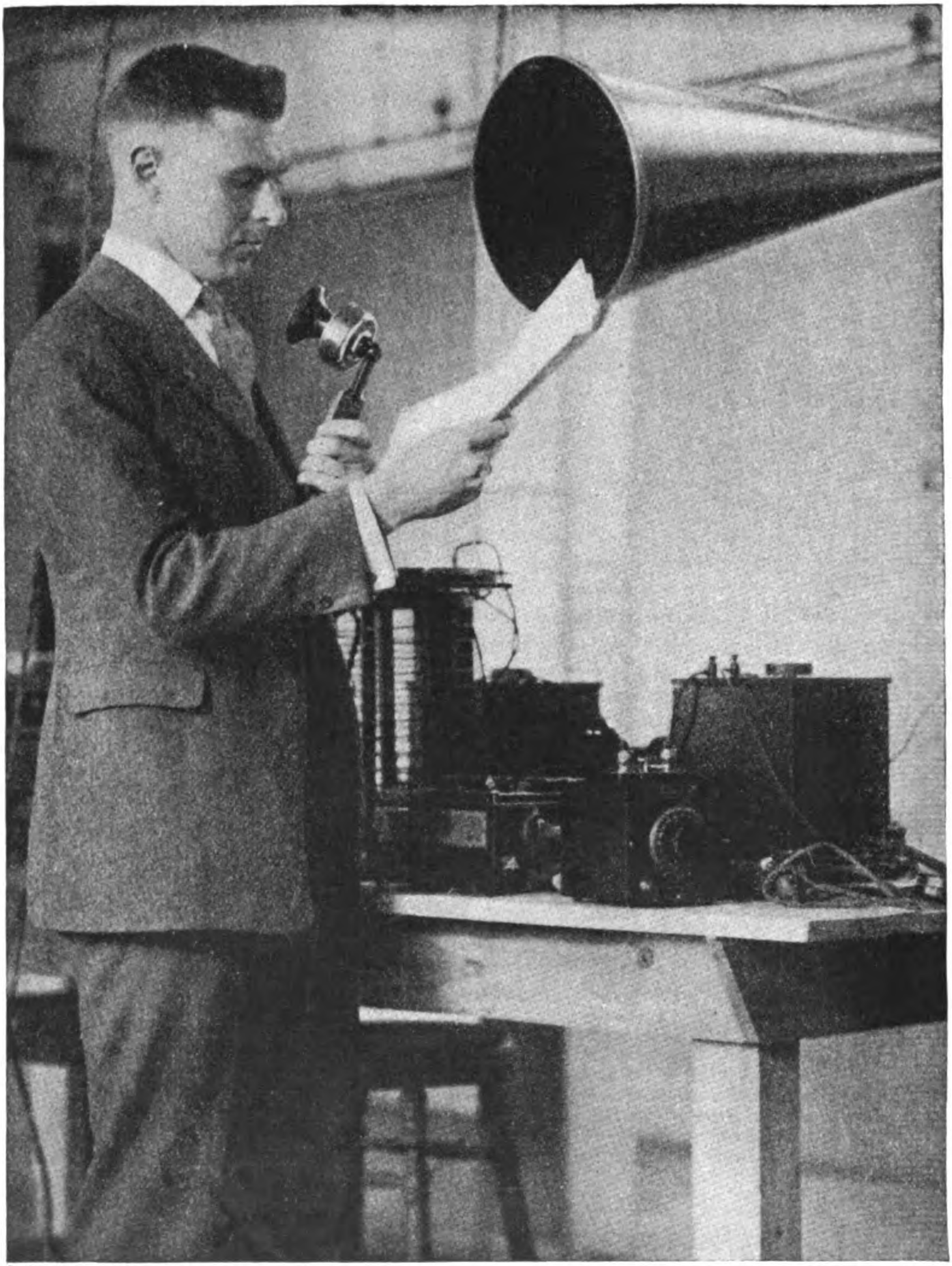
Yours faithfully

Herbert Hoover

HH.AGS.

SECRETARY HOOVER TO THE READERS OF *POPULAR RADIO*

Once upon a time the radio fan was afraid of so-called "governmental interference." This fear originated in the necessary repression of all but governmental and certain carefully guarded commercial stations during the war. Since then, however, the United States has done and is doing far more than any nation in the world to encourage the amateur in the development of the radio art—and will continue, as Secretary Hoover here assures the readers of POPULAR RADIO.



International

THE RADIO ON THE TRAIL OF THE CROOK

Every evening at about 8:00 o'clock the chief operator of broadcasting station WGI, Mr. L. D. Trefry, sends out police reports that warn the radio amateurs of New England to be on the lookout for certain fugitives whom the authorities are seeking. The station offers $10.00 to every amateur who assists in making an arrest.

Popular Radio

VOLUME I JUNE, 1922 NUMBER 2

Running Down Law Breakers *by* Radio

By FRED C. KELLY

THE radio was first used—and used successfully—for running down criminals as far back as 1902, only ten years after Sir William Crookes made the astounding announcement to the skeptical world: "Here is revealed the bewildering possibility of telegraphy without wires, posts, cables or any of our present costly appliances."

The significant police message was sent from Avalon, on the Island of Catalina, to San Pedro, on the mainland of California—towns which at that time had communication with each other only by slow mail steamers. The message announced that two colored thieves were about to land with their loot from a vessel which was specified.

The two thieves were arrested on the gangplank.

Between that elementary step and the most recent development of the radio in transmitting fingerprints and photographs of malefactors (a sort of long range Bertillon system of identification employed by the French government), a vast amount of experimenting has been done. Yet the uses of the radio by the police are only barely beginning.

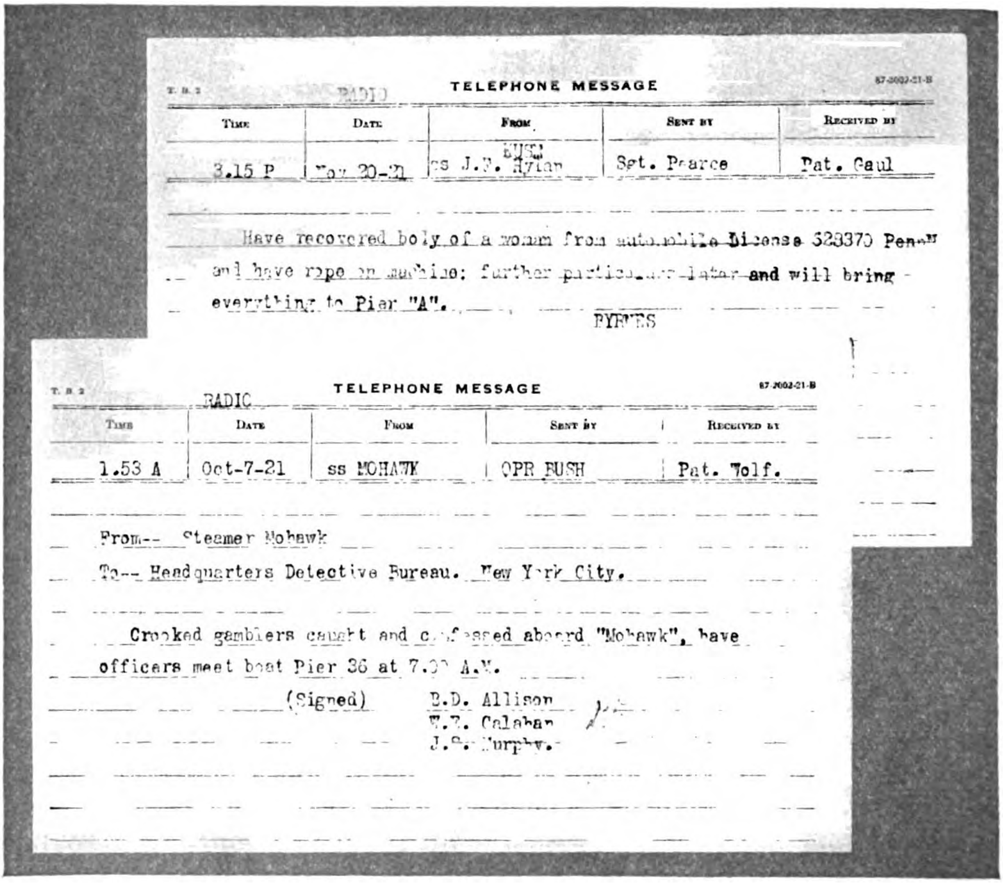
The Police Department of New York has equipped its police boats and is at present equipping its airplanes with radio apparatus.

The Police Department of Chicago is experimenting with direct communication between headquarters and its patrolmen on their posts.

The Police Department of Boston is broadcasting warnings every evening as a regular part of its daily routine.

And some of the most interesting uses of the radio in rounding up crooks by radio are now being worked out by the police of our smaller cities and towns, as is here told by a war-time official of the United States Secret Service and a well-known authority on detective methods.

—EDITOR



T. B. 2 RADIO **TELEPHONE MESSAGE** 87-2002-21-B

Time	Date	From	Sent by	Received by
3.15 P	Nov 20-21	BUSH PS J.F. Hylan	Sgt. Pearce	Pat. Gaul

Have recovered body of a woman from automobile License 523370 Penn and have rope on machine; further particulars later and will bring everything to Pier "A".

BYRNES

T. B. 2 RADIO **TELEPHONE MESSAGE** 87-2002-21-B

Time	Date	From	Sent by	Received by
1.53 A	Oct-7-21	ss MOHAWK	OPR BUSH	Pat. Wolf.

From-- Steamer Mohawk

To-- Headquarters Detective Bureau. New York City.

Crooked gamblers caught and confessed aboard "Mohawk", have officers meet boat Pier 36 at 7.00 A.M.

(Signed) B.D. Allison
W.T. Calahan
J.S. Murphy.

ACTUAL RADIO MESSAGES FROM THE FILES OF THE POLICE DEPARTMENT

How the radio enables headquarters to keep in touch with guardians of the law on the water and in remote places with which communication has heretofore been impossible, is evidenced by these typical radiograms

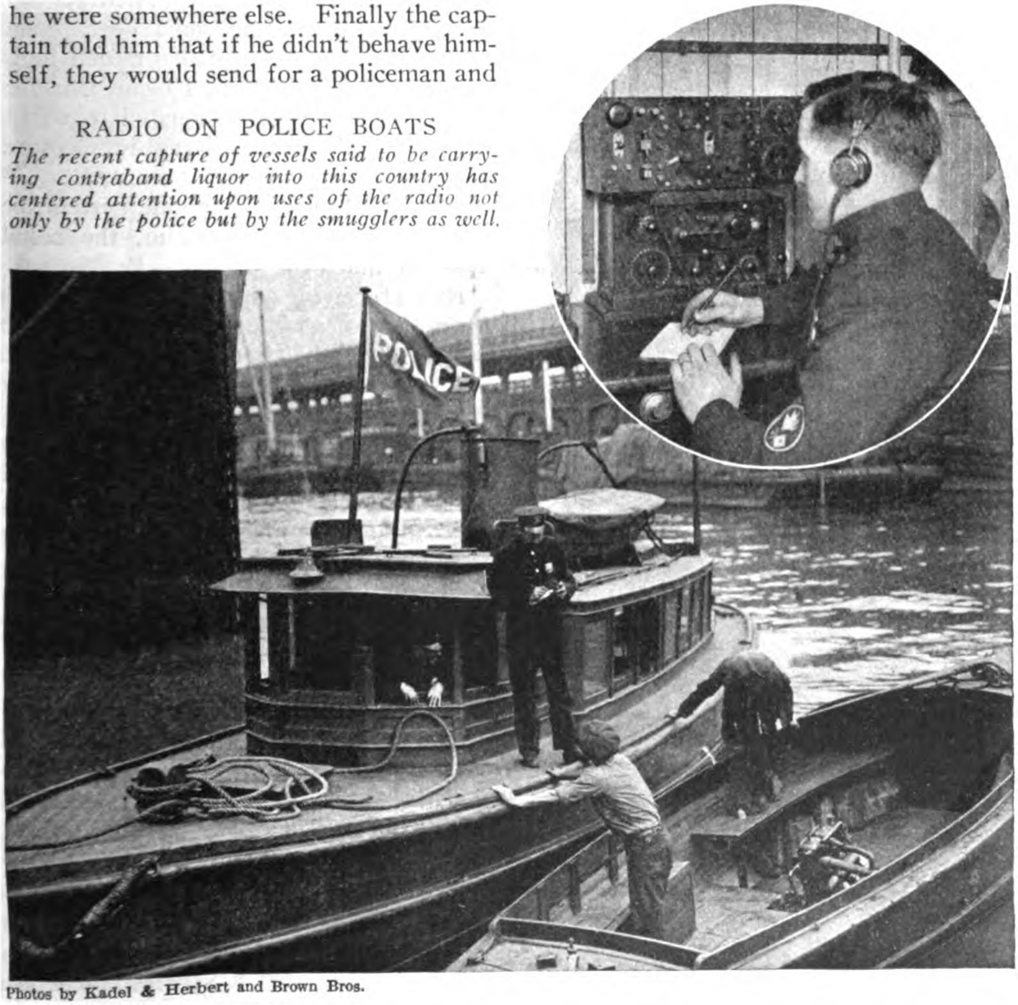
IF there is one thing I dote on it is crime. Though I have never taken an active interest in perpetrating crime myself, I like to know the mental processes of those who do. A burglar friend once told me of a scheme he had used for ascertaining if a family is temporarily away from home. He placed a small thin leaf in the keyhole of the front door and returned two days later to note results. If the leaf had been crushed by the inserting of a key in the lock, he would then know that the house was not deserted. But if the leaf was undisturbed, he intended to take a chance and break in. After hearing of this, I went to a police sergeant acquaintance to learn of police methods for protecting homes when the family is absent. He told me of various systems of burglar alarms, and the care required to have wires for such apparatus either buried or beyond the reach of anyone who might desire to cut them.

It is a fascinating battle of wits between those who are trying to enforce the law and those who would break it. In many respects the criminal has the advantage. He knows his own plans and also knows in a general way the working methods of the police, while the police know nothing of projects that a criminal may have in his head. Before a burglar enters a house, he finds out when the policeman patroling that beat is most likely to be somewhere else. But the policeman cannot plan definitely how to outwit the burglar because he doesn't even know that the burglar is going to be there. If he knew as much about the burglar's plans as the burglar does about *his,* his job would be easy enough. The best the police can do is to have a system so broad and sweeping that it will discourage crime wherever or however planned. This system is at times startlingly effective—and radio telephones are going to make it even more so.

On a small boat lying at anchor in New York harbor one night, a man became obstreperous and threatened to shoot the captain and others. He was so troublesome that several aboard almost wished he were somewhere else. Finally the captain told him that if he didn't behave himself, they would send for a policeman and have him placed under arrest. The idea of summoning a policeman out there in the middle of the bay struck the troublemaker as highly amusing, and he laughed heartily. A raucous, sneering laugh it was, like an old-fashioned stage villain.

But the situation wasn't so funny as he thought. In a few minutes a New York policeman stepped aboard and took the fellow in charge. The captain had 'phoned by radio to police headquarters and a message had been sent from there to the police launch which was less than half a mile from the disorderly man.

The New York police department is about to add other patrol launches, each equipped with radio receiving apparatus,



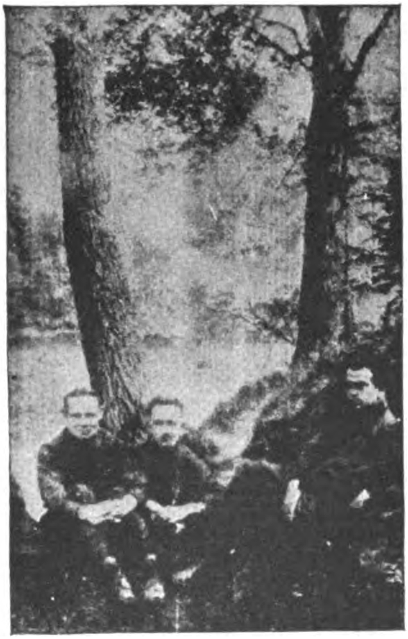
RADIO ON POLICE BOATS

The recent capture of vessels said to be carrying contraband liquor into this country has centered attention upon uses of the radio not only by the police but by the smugglers as well.

Photos by Kadel & Herbert and Brown Bros.

and criminals who seek to go down to the sea in ships may have many a plan upset. Scores of messages are telephoned to New York police headquarters each day from incoming and outgoing ships. I give elsewhere a few samples of these selected at random. Even so personal an enterprise as committing suicide is going to be more and more difficult.

Those not familiar with metropolitan police methods may be disappointed that radio telephones have not worked a greater revolution in means of communication between headquarters and men on the street. The one drawback to radio talk between policemen is lack of privacy. If a sergeant at central office should 'phone to an outlying precinct station to send reserves to Madison Square Garden because of a possible riot, and this message were picked up by amateurs, within half an hour the bystanders on hand at Madison Square Garden to witness the excitement might number about 2,000,000.



Central News Service

COULD YOU IDENTIFY THESE MEN?

This is what a photograph looks like after it has been transmitted over the Belin machine. The police of France are experimenting with this method of long-range identification.

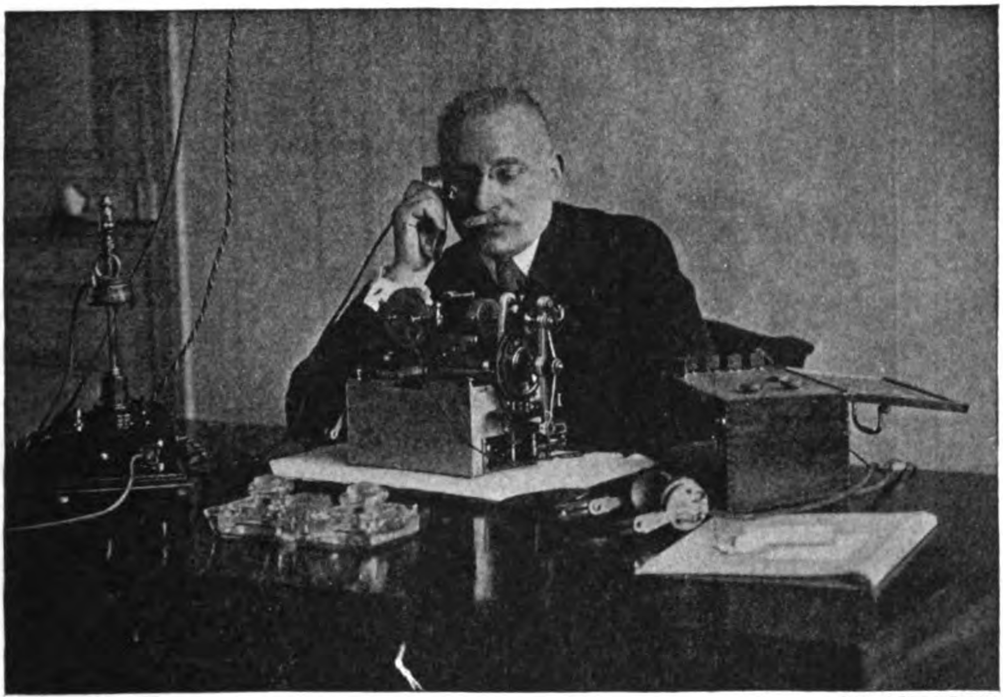
Moreover, even the old-fashioned telephone system has bigger possibilities than is generally understood. I sat one night talking with the desk sergeant in a precinct station when he received a message about an attempted burglary that he desired to give to Patrolman Potts, then strolling about his beat.

"I'll call Potts to the 'phone," remarked the sergeant, and he pressed a button. Four minutes later Patrolman Potts rang up from a police call box on a street corner, and inquired what was wanted.

The man at the desk had switched on a signal in a street lamp-post. This signal consisted of a green light—two short flashes, repeated every four seconds until it brought an answer. When several policemen are on the same beat, there might be a different signal for each individual. The usual plan, I believe, is for one patrolman to be designated to watch for the signal and then carry the message to the fellow-officer who is wanted.

If, instead of a wire 'phone system the message were sent by radio, the result might be much the same.

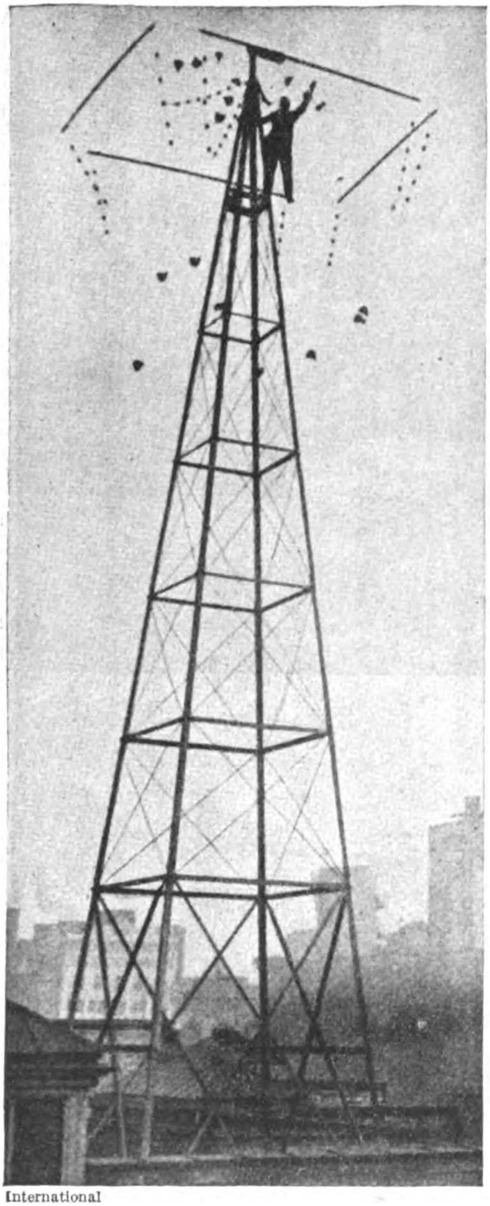
Radio receiving apparatus small enough for a man to carry in his pocket has been perfected. But it is necessary to wear a headgear with receivers over the ears and if all policemen wore these as they walked about the streets they might receive radio messages, but might fail to hear much else. For the present, police radio messages are likely to be sent only to regular receiving stations, placed at strategic points, and the chances are that it will be some time before patrolmen regularly receive orders as they pace about their beats. But already in use in Chicago is a police automobile equipped with both receiving and sending apparatus. While there is the handicap already mentioned that the messages lack privacy, this outfit has distinct possibilities. With it a policeman could chase an automobile thief or a murderer and report progress to his chief, ask for further orders, or have other pursuers sent in another direction. The trouble is, though, that a straightaway long



Central News Service.

A MACHINE THAT TRANSMITS FINGER PRINTS BY RADIO

The recent announcement that the Police Department of Lyons, France, has adopted a device for sending portraits of crooks by radio brings into prominence the invention of Edouard Belin, the telestereograph. Belin's apparatus consists of a copper cylinder, not unlike that in one of the early Edison phonographs. This cylinder is made to revolve while at the same time a microphone diaphragm (somewhat resembling the sound box of a phonograph and a recording stylus) passes slowly along it in a lengthwise direction. The picture is placed face downward on the copper cylinder after the latter has been covered with shellac; the cylinder is then placed in hot water so that the paper may be removed while the gelatine film of the print is left on it. Some of the gelatine is dissolved but this dissolution is proportional to the lights and shadows of the picture; because of this fact the picture forms a bas relief upon the cylinder with the darker portions higher than the lighter ones, inasmuch as the darker parts are more resistant to the action of the water. The cylinder is then placed in the machine and the apparatus set in motion. The stylus of the microphone presses against the surface of the picture, covering point by point every part of it, thus causing the microphone diaphragm to vibrate to a greater or less extent, according to the height of any given portion of the bas relief. As this diaphragm is exactly like the transmitter of a telephone except that it is moved by the stylus instead of sound waves, it sends impulses of electricity to the receiving apparatus. The path made by the stylus over the revolving cylinder is spiral in form. At the end of the wire is the receiving apparatus. This comprises a cylinder which moves at exactly the same rate of speed as that of the sending apparatus, but instead of the metal needle which formed the transmitting stylus or "translator" the stylus here, whose function it is to impress the sensitive film upon the cylinder, is a fine thread of light. The electrical impulses which are sent over the radio or wire from the gelatine film as just described, set in motion an extremely sensitive galvanometer, in which there is a delicate quartz thread bearing a small mirror. This mirror is twisted slightly in one direction or the other in precise accordance with the movements imparted by the stylus to the microphone at the transmitting end. At one side of the mirror is a lamp whose rays are focussed upon it; this pencil of light shifts its position so that it reproduces upon the cylinder the lights and shadows of the original picture.



International

THE AERIAL OVER THE POLICE HEADQUARTERS OF CHICAGO

During the past few months experiments have been carried on in Chicago by George E. Carlson, of the Department of Gas and Electricity, for keeping police headquarters in constant touch with its patrolmen by means of the radiophone. The experiments are significant in that they anticipate what will probably be a highly valuable application of wireless. This picture shows the aerial located on the roof of the Chicago City Hall, in which the police headquarters are located.

distance chase between a criminal and a policeman is a rare occurrence. We see such things in moving pictures but rarely anywhere else. The difficulty about catching a criminal is that one usually doesn't know which direction he took. Hence, the only way to catch him is to notify people in *all* directions to look for him. This is where the greatest use of radio telephones for thief catching seems likely to be—broadcasting descriptions and other information from the police of one town to another and to the public.

With the number of private radio receiving outfits likely to be in use a year from now, an escaping criminal would not feel safe in approaching any farmhouse for food or shelter, no matter how obscure the lane on which it is located. Robert Fay, the German agent who made a marvellously ingenious escape from Atlanta penitentiary and got to Spain before he was captured, once told me how he never went to a farm house for food until he had first made certain that no telephone wires entered it. Absence of telephone wires will no longer give an escaping criminal safety.

I once asked a famous New York criminal what he would do if he suddenly found it necessary to disappear from his ordinary haunts and keep in hiding for several months without danger of being traced.

"I'd take a lower berth from New York to Canada," he replied, "and when I got well up into the woods, I'd open the window in my berth at some little siding or small way station and drop off the train unobserved. I probably could stay about there in the woods, at farm houses and small villages for a long time before it would occur to people that I was anybody in particular. Few of the natives in such outlying places have telephones or bother to read the newspapers."

There are a number of flaws in this scheme that I need not go into here. But the main point is that when nearly all the country people have radio receiving outfits, as seems likely to happen, there won't be any more outlying points.

The greatest weakness in our police system is that it is local rather than national. There is surprisingly little systematic co-operation between the police of different cities. They are willing enough to help each other, but are poorly organized to do so. If a clever forger victimizes banks in Detroit, then in Cleveland, it should not be difficult for the police in Pittsburgh or Buffalo to figure out that he is evidently working eastward. But they probably never know this until too late. Radio broadcasting of such information should help to unify police work over a wider area.

One of the first cities to seize the opportunities offered by radio 'phones for police work was Dallas, Texas. This was the result of a letter to the Dallas police department from Frank M. Corlett, manager of a Texas division of The American Radio Relay League, the big national organization of amateur radio operators. Corlett proposed that the local police broadcast such information as they wished to make public about crime, and let amateurs throughout Texas and adjoining states turn this over to the police or constables of their communities. As the police department had no radio apparatus at that time, the broadcasting was done at first by Mr. Corlett. After the value of the plan was proved, the city bought apparatus for the police department. The station has ordinarily a range of 200 miles in day time and 500 miles at night. Messages have been heard as far away as North Dakota and California. Louis W. Turley, the Dallas police and fire commissioner, declares that one capture which resulted more than paid for the installation of the apparatus. By way of rewarding the amateurs who receive their messages and co-operate with them, the Dallas police not only send out crime reports, but furnish a complete daily entertainment—concerts, news of sports, sermons, lectures, and other features. So far as I know this is the only municipally-owned radio outfit that furnishes such service and is probably the first time on record where a police department has ever made itself so entertaining as well as useful.

An important feature of the radio as applied to the running down of crooks is the chance it gives to the radio amateur to take part in the capture of the fugitives. One of the most spectacular of these incidents occurred recently on a payday in the small town of Crafton, Pa. The doors of the First National Bank had been open half an hour and the employees were making up the payroll for some

International

That the radio apparatus installed on this police car is no toy is indicated by the size of the resonance coil that is supported by an especially built framwork.

twenty firms, when a car drove up outside and stopped. In the car were five men, including the driver. Quickly four of them entered the bank and drew the blinds, while the fifth remained seated in the car.

"No funny business now," warned the leader of the visitors. "We want that money."

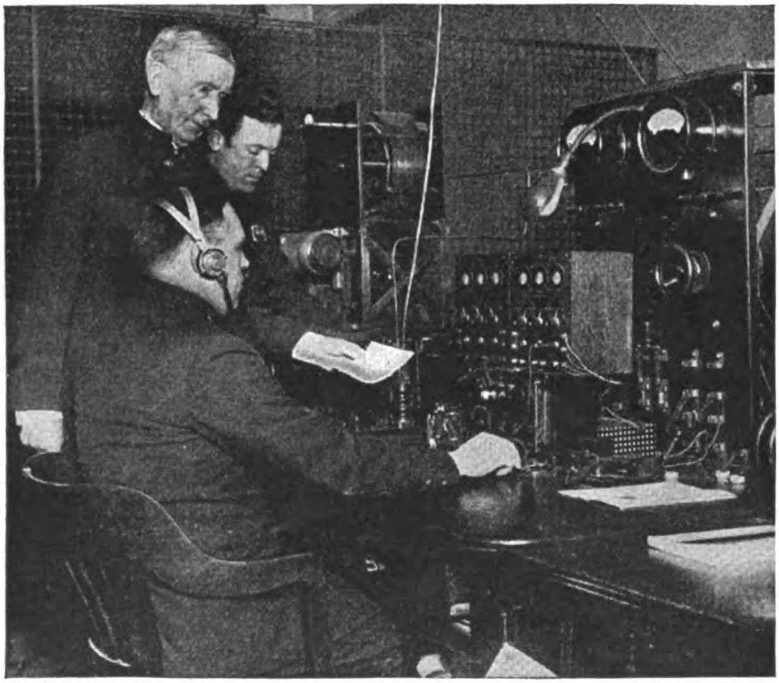
The employees of the bank were driven into the vault, at the point of the revolver, but as the teller went in he succeeded in throwing the safety switch so that the air-tight door could not be closed. This left only the "day door"—and for his pains he received a clubbing from a revolver in the hands of one of the men.

The assistant cashier was standing at a cabinet examining a note when the men entered. On the window sill near him was a pistol. He started to reach for it.

"Get that guy," one of the robbers yelled.

The cashier darted for the weapon, but a bullet reached him. He was killed.

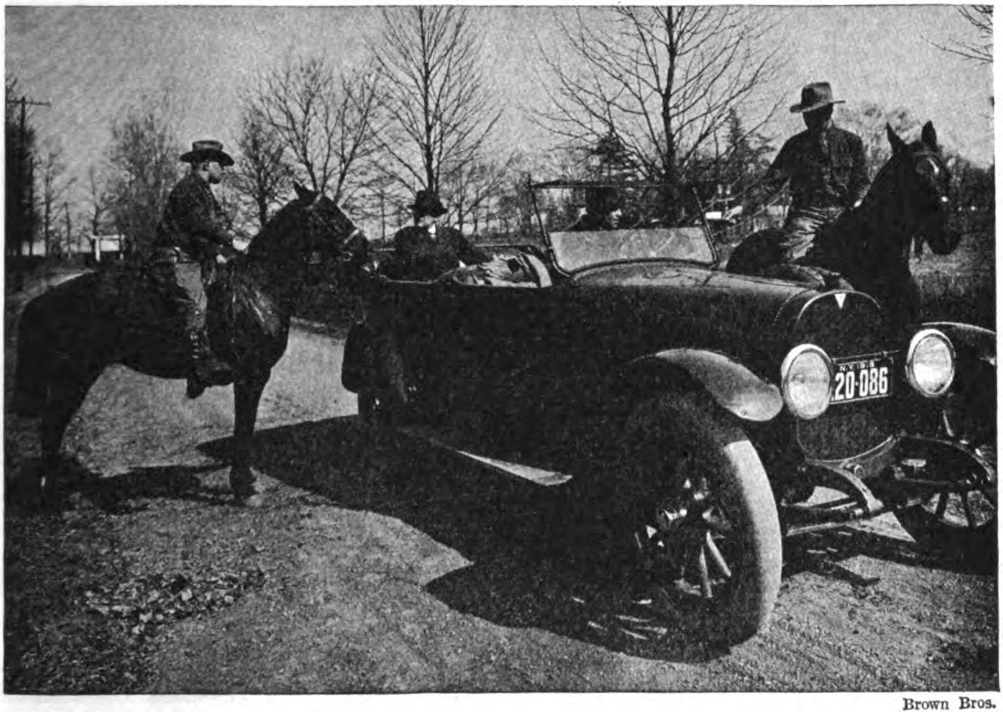
Scooping up $24,000 the four men ran down the steps to the machine and sped away. Just at this moment Hebert W. Haberl, a sophomore at the Carnegie Institute of Technology, came around the corner on the way to the bank to make a deposit, arriving in time to catch a glimpse of the speeding machine and to make a note of the plate number. Rushing back to his home-made radio set, he sent out an emergency. An amateur in Pittsburgh, eight miles away, picked up the message and hastened to his car, drove to the police station where he picked up five detectives and gave the police their first information about the robbery. The pursuers rushed toward Crafton. On the way they met the bandits' car, and recognizing the plate number, they opened fire. The bandits' car was finally wrecked and



Kadel & Herbert

WHERE THE OUTGOING POLICE MESSAGES ORIGINATE

At New York police headquarters, where connections are maintained with the police boats especially and where it presumably will be maintained in the not distant future, with the squadron of airplanes that constitute a part of New York's police patrol.



Brown Bros.

IN THE OUTLYING DISTRICTS THE RADIO WILL BE INVALUABLE TO THE POLICE

Among the State constabulary forces and such far scattered forces as the Northwest Mounted Police of Canada, the radio will eventually be extensively used in the running down of criminals.

the money recovered, although the robbers succeeded in escaping.

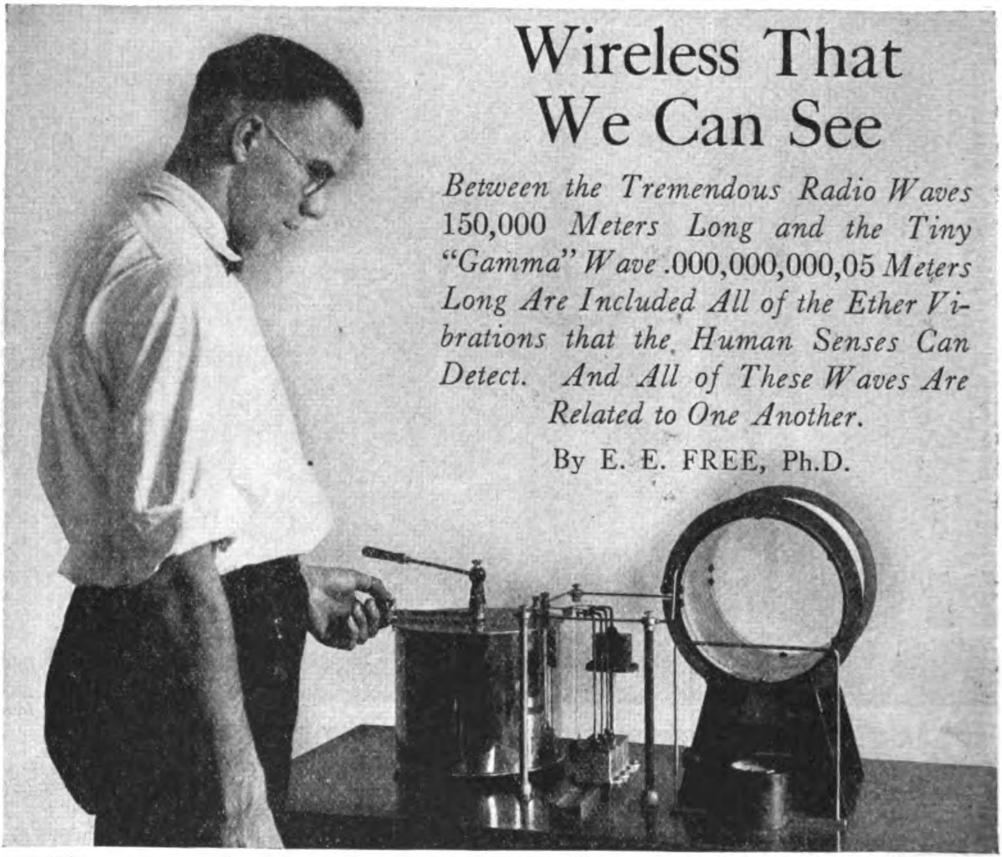
Notwithstanding the big possibilities of radio 'phones for rounding up criminals, it is easy to exaggerate. No one appreciates so well as the experts that the system will have its limitations. This is true of every great invention. Those who know best what a thing can do and why it does it, are the ones most capable of seeing also what it cannot do. One of the most conservative men I have ever talked to about the ultimate speed and uses of the aeroplane is Orville Wright, who invented it. I have not heard of a radio expert who expects the wireless 'phone to supercede the wire 'phone for police communication. But it is certain that broadcasting will be an important adjunct to criminal detecting methods now in use. The cost of reaching hundreds of small villages and outlying country sections by telegraph or ordinary long distance 'phone would be so great as to be prohibitive. By radio the cost is so trifling that it is well worth while to send out bulletins even though only a small percentage of shots hit a mark. And the fact that the radio service used by the police at present is effective augurs what developments will take place.

¶ While the police are experimenting with radio, the crooks are actually using it—and using it extensively, as the recent investigations into the activities of the rum-runners show. In the July issue another member of the Secret Service will tell how the crooks are doing it, and how they are being caught at it.

Wireless That We Can See

Between the Tremendous Radio Waves 150,000 Meters Long and the Tiny "Gamma" Wave .000,000,000,05 Meters Long Are Included All of the Ether Vibrations that the Human Senses Can Detect. And All of These Waves Are Related to One Another.

By E. E. FREE, Ph.D.



The wavemeter developed by the Bureau of Standards for measuring wavelengths.

SOME DAY we may be able to hear light as well as to see sounds. Indeed, science has already made it possible to make visual certain sound waves—or at least the effects produced by sound waves. An example of a photograph of a sound (called an "occillogram"), is reproduced at the top of Page 90. It is not at all inconceivable that when more is known of the range of ether waves and the two as yet unexplored areas are understood that some amazing possibilities will be opened up for appealing to the human senses in ways that are not yet known.

Light and wireless are the same thing. Light is a kind of wireless composed of waves with a very short wavelength. X-rays are wireless of still shorter waves. Shortest of all are the wireless waves called "gamma rays"—the rays given out by radium, the last despairing S O S signal of the radium atom as it explodes.

All of these rays and waves, light and wireless and the others, are waves in the ether, waves of the kind called electromagnetic. Electromagnetic waves are waves started by electric disturbances. They are similar to the waves which you start on the surface of a still pond of water when you drop a stone into it. The various kinds of ether waves, just like the water waves may be classified according to wavelength, according to the distance from the crest of one wave to the crest of the wave which follows behind it.

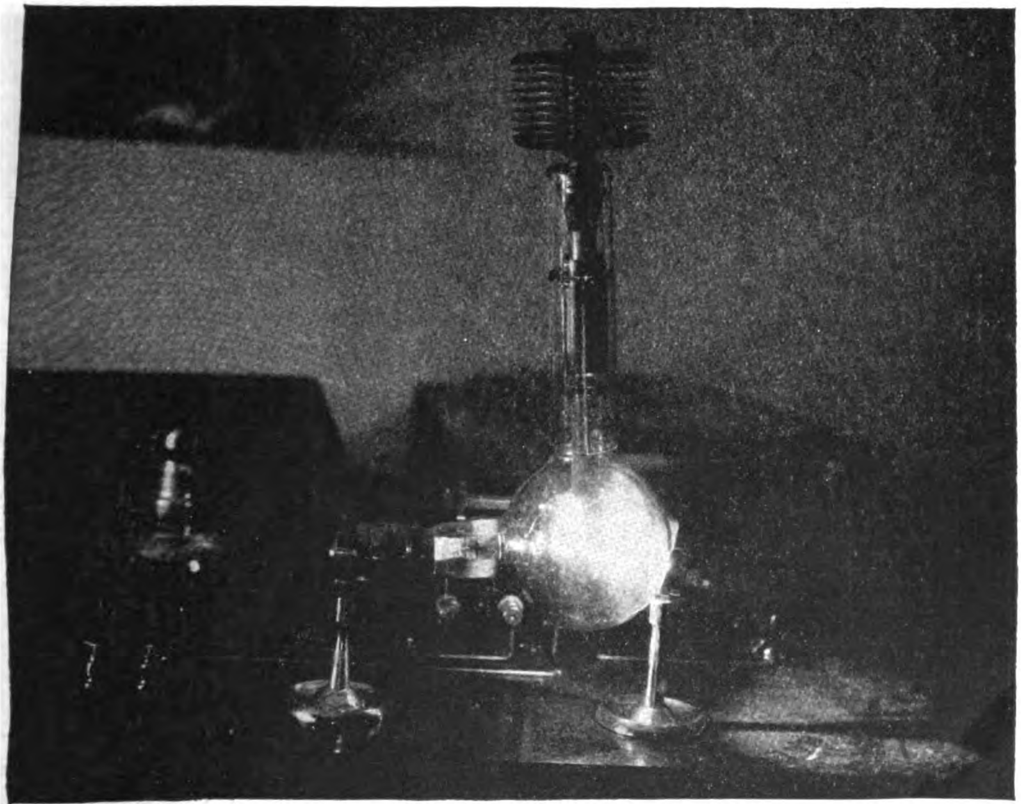
The great water waves of the ocean, the waves which roll in as breakers onto the beach, may be hundreds of feet from crest to crest. That is, they have a wavelength of 200 or 400 or 600 feet, whatever the crest-to-crest distance may be. The tiny waves in the still pond into which you have dropped a little pebble may be only an inch or half an inch or even less, from crest to crest. But between the pond wavelets with a wavelength of a fraction of an inch and the mighty ocean waves of lengths up, perhaps, to half a mile, there is no real difference in kind. There is only a difference in size in wavelength.

Exactly so with light and wireless. There is no difference in kind, in real nature; there is only a difference in wavelength.

But, of course, this difference in wavelength is a very real and important difference. Our eyes happen to be adjusted to perceive, to "see" only a certain range of wavelengths, a rather limited range, too. And all of these "visible" waves are very short. Even thousands of millions of them would not equal the length of some of the great waves of wireless.

X-rays are shorter still, but of the same family. Violet rays, the so-called "infra red" rays or radiant heat, the "gamma ray," all these are other brothers. They are exactly the same thing as light and wireless; they are merely longer or shorter; they differ only in wavelength. All of them are waves in the ether. All are of the same race and nature, alike just as the pond wavelet and the great ocean roller are alike. And they differ only as these two differ—in size.

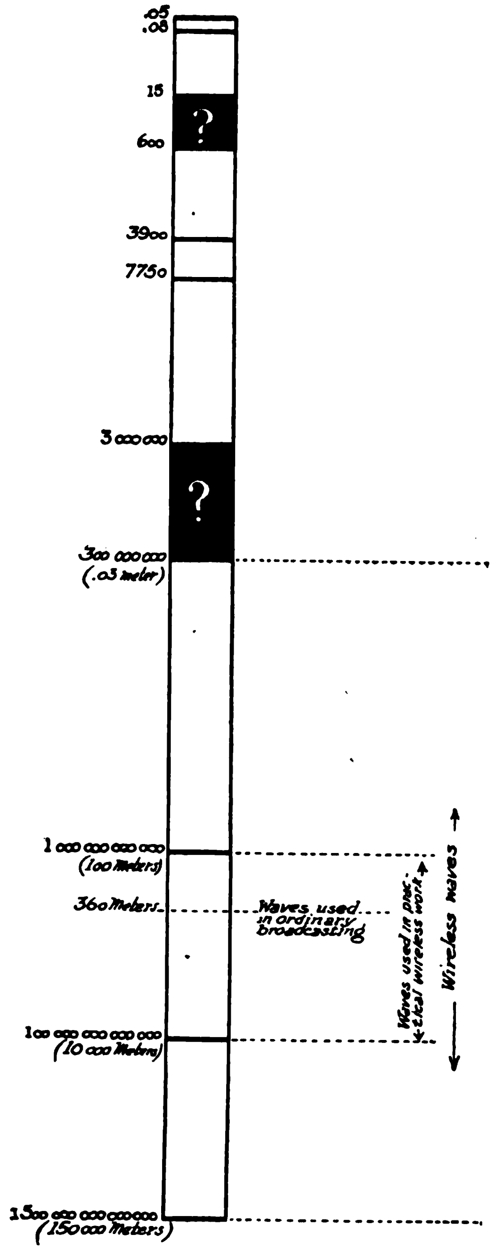
Now let us see just what these size differences are. The ordinary waves of practical wireless are from 100 meters to 10,000 meters long. That is, from the crest of one wave to that of the next one, as they follow each other along through



General Electric

A COUSIN OF THE RADIO WAVE

The X-ray tube invented by Dr. W. D. Coolidge. It operates on the same principle as the audion tube. Unlike its predecessors, it can be used continuously and does not require adjustments of the vacuum.



THE ENTIRE ETHER WAVE FAMILY, SHOWING THE TWO UNKNOWN BROTHERS

The relationship between the radio waves and the various light, sound and other waves are illustrated in this diagram. These wavelengths are indicated in Angstrom Units. Note the two as yet unexplored areas.

space, there is a distance ranging from 100 meters to 10,000 meters, (328 to 32,808 feet) depending upon the wavelength that is used in radio transmission.

In experimental work (though not, so far as I know, in practical wireless), ether waves of both longer than 10,000 meters and shorter than 100 meters have been produced, transmitted, and received.

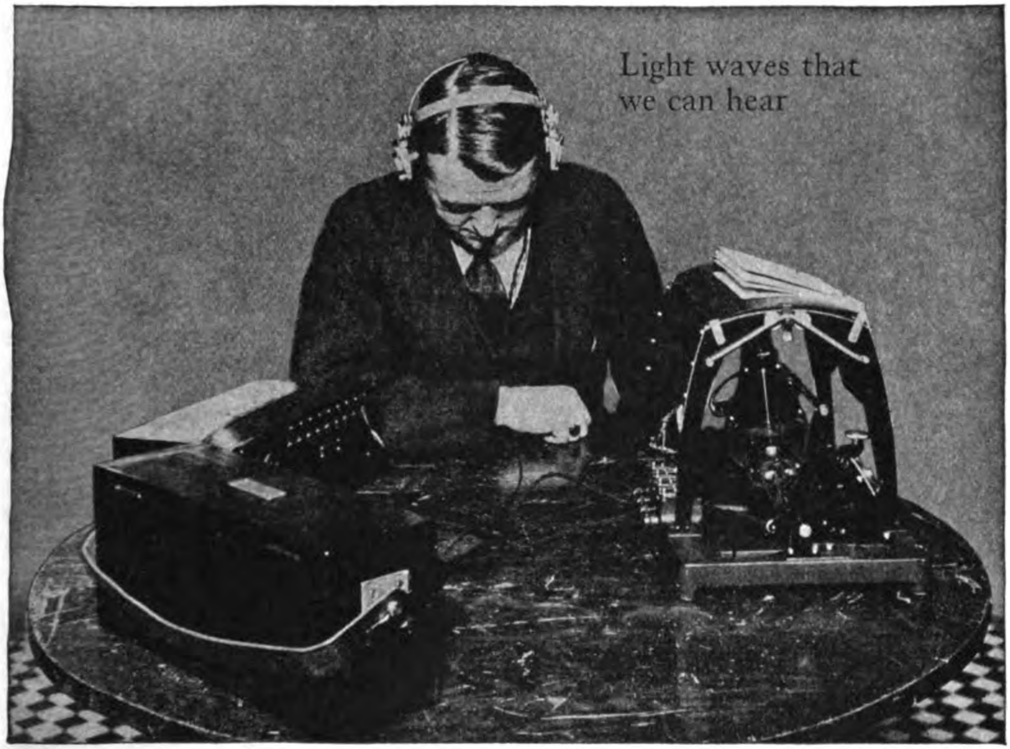
And while we are considering extra long waves we must not forget the very long impulses which Marconi has picked up and which he believes to be of an origin outside the earth, perhaps from Mars. These remarkable waves are reported by Marconi to have been sometimes as long as 150,000 meters, which is, I believe, the longest ether wave yet detected (or produced) by human agency. One hundred and fifty thousand meters is 492.000 feet. or over ninety-three miles—a distance as great as that from New York to Philadelphia—for illustration.

This is the great-grandfather of the whole wave family. With it the series of ether waves begins.

The next shorter wave than this, the slightly younger brothers that are not quite so tall, are the usual wireless waves that run down to about 100 meters long. Within this range we can get, and do get and use, practically any wavelength we want. All are about alike. All are produced by sparks, or other electric disturbances, and are picked up and translated for us by audion tubes, crystal detectors or similar devices.

Even below the 100 meters which we are thinking of as the lower limit of wireless, the waves remain about the same. They are created similarly. They can be similarly picked up and detected. Only, as every wireless fan knows, they decrease in range, in ability to go a long way through the ether.

But suppose we decrease continually the wavelength of our wireless; suppose we produce shorter and shorter waves, waves down to a length of one meter or of one-tenth of a meter, or even less. What will happen then?



Light waves that we can hear

Keystone View Co.

A MACHINE THAT CONVERTS LIGHT WAVES INTO SOUND

By means of this device called the optophone, invented by Dr. E. E. Fournier D'Albe, the letters on a printed page are, by a process of illumination, translated into a series of noises which the blind can interpret in the form of words.

A curious phenomenon takes place. As we decrease the wavelength the waves become less and less like typical wireless waves and more and more like another kind of wave—a kind of wave which seems, at first sight, to be totally different. More and more like waves of—what do you think?

Heat. Plain ordinary heat—the heat you feel when you stand in front of an open fire; the heat given out by the filament of an electric lamp.

Are heat waves, then, the same as wireless waves?

Certainly they are. They are merely very much shorter waves. The fire is wirelessing to you when you feel its warmth.

In actual length, measured in meters, the heat waves are very short. The longest of them which have been studied by scientists are about .0003 meter long, or about one-tenth of an inch. The shortest wireless waves which have been studied so far in the laboratory are about one hundred times this long, or about .03 meter, or nearly 12 inches. There is, therefore, a gap between the longest heat waves and the shortest wireless waves, a gap not yet filled in by scientific knowledge.

Before we investigate this undiscovered gap, let us go on running our eye down the ether wave family. What are the still shorter waves like, the waves shorter than the heat waves from the fire? Here there is no gap. Heat waves shade insensibly into visible light.

Suppose you heat a piece of iron in a flame, or better still, by passing an electric current through it. First it is cold to the touch, then warmer; warmer that is, to actual contact of your finger. Gradually it gets warmer still. You can feel the heat from it even when your hand is an half inch or so away. You do not have to touch it.

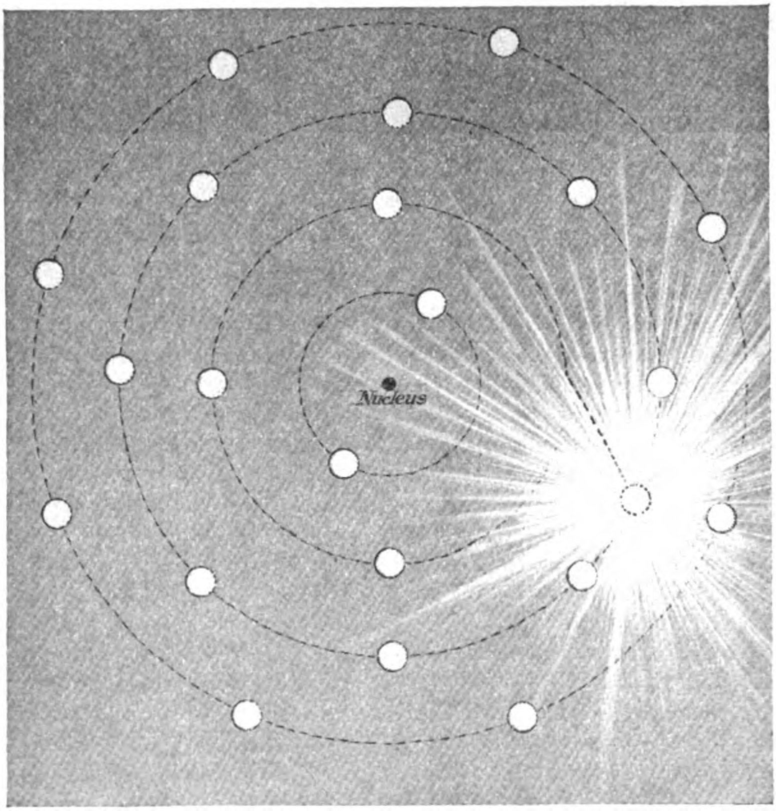
This is radiant heat. The iron is giving off rays of heat, the shorter wireless waves just like the wireless waves that come from the fire.

But the iron gets still hotter. It radiates more heat, and you would learn, if you analyzed these heat rays by means of physical instruments, that the wavelength of the rays was getting shorter. That as the iron got hotter it gave off shorter and shorter rays of heat.

Presently the iron glows. It gives off light. At first this light is a dull red light. What has happened?

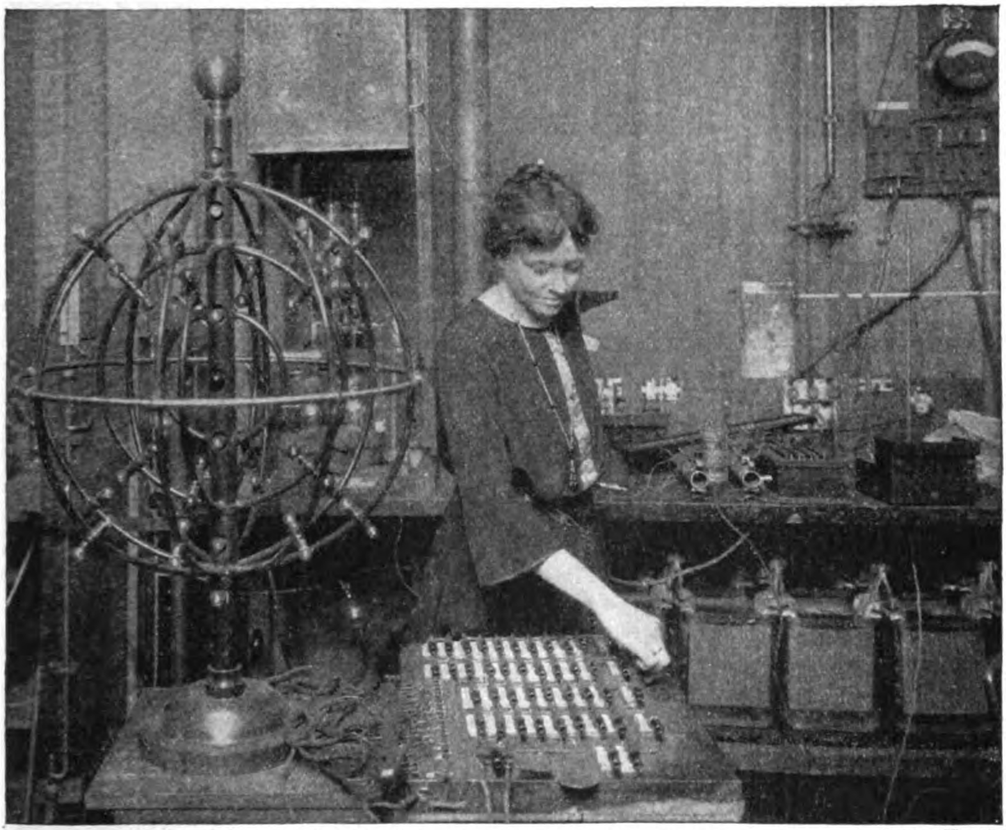
Merely this. The heat rays have gotten short enough to be visible. They have become light.

At first, as everyone knows, the light is red. But higher heating produces not only more light from the iron, it produces a different light; a light of different shades; first orange and yellow and finally, when the iron is very hot, a pure white. This, too, is merely a matter of wavelength. Red waves are the longest visible waves, the longest kind of light. Orange waves are a little shorter, yellow a little shorter still. The entire spectrum, the six colors of the rainbow, are distinguished physically only by the wavelength of the light. Next in length to the yellow wavelength is green, then blue, and finally violet, the shortest of all. White light is merely a mixture of all of them, of waves of various wavelengths.



HOW AN ATOM PRODUCES LIGHT

Occasionally one of the electrons that move about the nucleus of the atom jumps from its own orbit into another. This phenomenon produces a pulse of light.



General Electric

A GIGANTIC MODEL OF AN ATOM

The electric lights represent the electrons that revolve about the nucleus. By a manipulation of the switchboard any combination of electrons from 1 to 56 may be represented by the lamps.

The numerical wavelength at which radiant heat ceases to be heat and becomes red light is a wavelength of about .000000775 meter, less than one-millionth part of a meter.

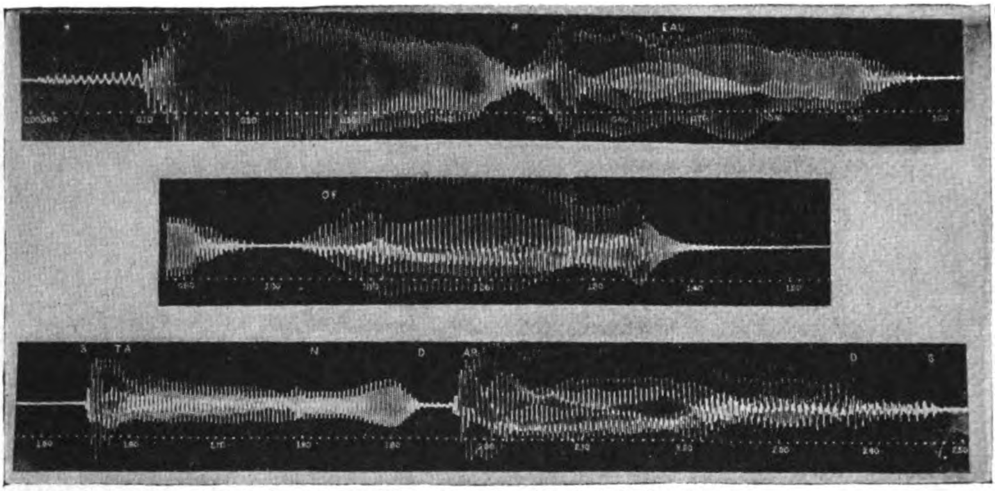
For convenience (since the rays of light are so short relative to the meter), these wavelengths are not usually set down in meters but in what are known as "tenth-meters" or Angstrom Units, which are ten-billionth parts of a meter. Ten billion of these units make one meter. The wavelength of red light, the just visible light on the border between light and heat, is, therefore, about 7750 Angstrom Units.

Of course this limit, this longest wavelength of visible light, has no physical meaning. It depends merely on your eye. The eye happens to be able to see a wave of this length. It cannot see one of say 8000 units. It is possible, even, for the eyes of two people to differ in ability to see red light. Some persons, for instance, cannot see in the spectroscope the deep red line of the spectrum of potassium. For them this line—it has a wavelength of 7702 units—is not light at all; it is heat. Others can see it. For them it is light.

The limits of wavelength that mark off the different colors, as determined for the average human eye, are as follows, all given in Angstrom Units:

Red	7750 to 6450
Orange	6450 to 5900
Yellow	5900 to 5600
Green	5600 to 4900
Blue	4900 to 4500
Violet	4500 to 3900

Of course these figures are only ap-



From a photograph furnished by Prof. D. C. Miller, of the Case School of Applied Science.

A PHOTOGRAPH OF THE SOUND PRODUCED BY THE HUMAN VOICE

This is literally a picture of the spoken words "Bureau of Standards"—a sound wave that we can see. The waves are recorded on the waving lines of this "oscillogram," as the picture is called.

proximate. Eyes differ much in ability to see different colors even when people are not consciously color-blind.

The fact that vision or visible light depends on a bodily organ—the eye—is evident, also in the limited number of wavelengths which constitute this visible light; that is, it is limited in comparison with the many wavelengths of heat waves or of wireless waves. Heat waves may vary in wavelength from the 7750 units of the shortest heat wave to over 3,000,000 units. The entire spectrum of visible light, on the other hand, is confined between wavelengths of 7750 units and 3900 units.

But what lies below 3900 units? Are there still shorter waves?

Indeed there are, many of them. Immediately below light and differing from light only in happening to be invisible to the human eye are the waves of the so-called "ultra-violet light," or the violet ray. These extend, with decreasing length to a wavelength of about 600 Angstrom Units. They affect photographic plates just as light does. They may be collected and dispersed by lenses as light is. In fact they *are* light—but invisible light. The eye does not happen to be able to see them. There is some evidence, indeed, that the human eye may be exceptionally deficient in this, for the eyes of certain insects and animals may be able to see ultra-violet light which is invisible to us, just as the insect ears are believed to be able to hear sounds too shrill for our ears to catch at all.

Below the ultra-violet, below a wavelength of 600 units, there is another gap in the series. One of the wavelength brothers has died, or he is hiding out and we have not yet discovered him. No ether waves are known from about 600 units to about 15 units. This does not mean that they do not exist. Probably they do. Any day some inquiring scientist may turn over an experiment and find the missing brother of the wave family.

At a wavelength of about 15 units begins one of the most remarkable kinds of radiation in the entire family, the X-ray. Much like light, yet with remarkable power of penetrating opaque matter, X-rays have proved to be one of the most useful tools of medicine and surgery and a great aid to scientific research as well. By using them it has been possible to investigate the atomic structure of crystals, almost to see the atoms as they lie side by side, as regular as the soldiers of a well-trained army, inside a tiny crystal of common salt. But all this is another story.

The shortest X-rays now known are about one tenth of a unit long. But there is still the younger, shorter brother, the gamma rays given out by radium. These rays have, apparently, wavelengths of from .05 to .08 unit. They are the latest form of radiation to be discovered. As yet not much is known of them. But they are, like all the others, waves in the ether, just like X-rays and light and radiant heat and wireless, except that they are shorter. They are the wireless of the radium atom, the ethereal cry which goes out from the atom when it suffers the atomic explosion that causes radio activity.

It is a long series, this family of ether waves, and a great family. It comprises wavelengths so different that even their difference, expressed in figures, is beyond our mental grasp. From 150,000 meters to .05 of one Angstrom Unit—or .00000000005 of a meter. Thirty thousand million millions of these .05 unit gamma ray waves equal in length only one of the great wireless waves detected by Marconi. A figure so vast is beyond the reach of real comprehension.

How are all these waves caused? What produces the different kinds of wave motion, of wave energy?

The longest of them, the true wireless waves, start from movements of electric charges, from surges of electricity in and out of antennae or from alternations of the direction of the current from a dynamo or a vacuum tube generator. The next longest ones, the heat waves are started by vibrating molecules.

And the light waves, so physicists have come to think, are started by vibrations inside the atoms themselves, by movements of electrons from place to place inside the tiny intra-atomic solar system. They are atomic wireless. The X-rays, also, are atomic in origin; probably due, as are the light rays, to vibrations of the electrons. The gamma rays are caused, we think, by similar internal vibrations in the atom, but by more violent ones, by the vibrations which accompany the explosion of the atomic nucleus.

All of these waves are wireless waves; wireless from molecules, dancing the constant dance of heat; wireless from electrons dancing inside the atoms of luminous substances; wireless from the atomic convulsion in which the radium atom dies.

Wireless is not limited to the ether wave which you pick up from your friend's sending station in the next block.

So much for the ether wave family. But what about the gaps in the family—about the missing wavelength brother?

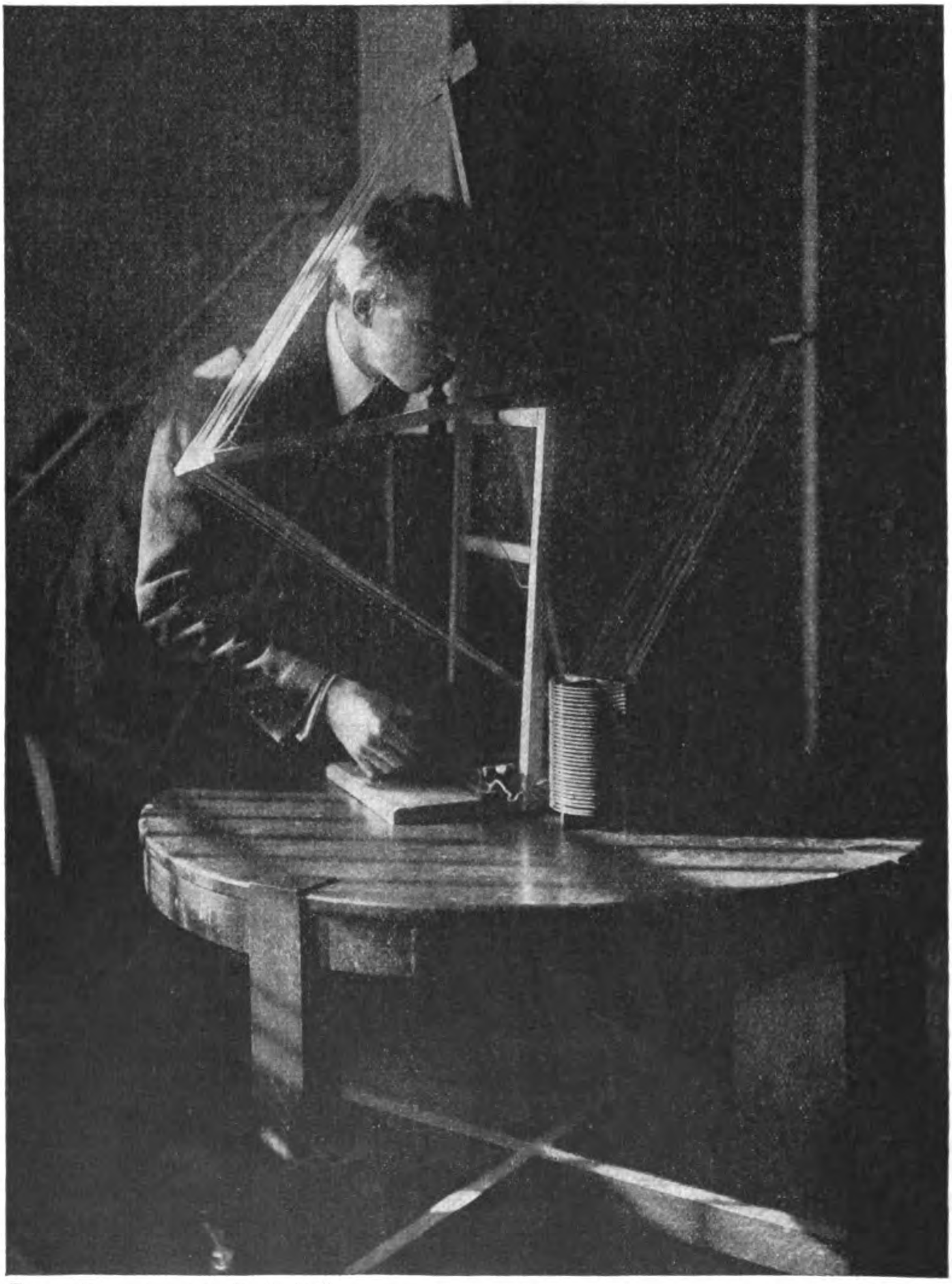
The brother that I would most like to meet is the one between heat waves and wireless, between wavelengths of about one tenth-inch and of about 12 inches. These waves are not known. What are they?

Possibly they are merely heat waves like their shorter brothers or wireless waves like the longer brothers.

But perhaps they are not quite like either of these. There is one important difference between heat waves and wireless waves; that is the difference in human perception of them. Heat waves we can feel with the skin, probably with all of our nervous tissue. Wireless waves we cannot feel or perceive at all, so far as we now know.

Now at what wavelength does the heat sensation stop? Can we extend it? Can we extend it even to wavelengths within the wireless field? If we studied thoroughly these intermediate waves—the waves which belong to the missing brother of our family—could we devise methods, perhaps, to perceive wireless waves directly, learn how to feel them, train our nerves to pick them up, to act as a sort of bodily detector?

This is speculation; these questions are imaginative. I don't know the answers to them. But some day the wireless experimenters are going to find out.



From a photograph made for Popular Radio

USING A LOOP AERIAL FOR TESTING THE DYNAMIC ACTIVITY OF THOUGHT

If the human brain emanates definite waves or vibrations, Dr. Carrington points out, they will conceivably affect the electric current that flows around the loop—providing the apparatus is sensitive enough. The problem of the scientist is to create instruments that are sufficiently delicate to record such impulses.

THE FIRST OF TWO REMARKABLE ARTICLES THAT TELL HOW PSYCHIC INVESTIGATORS ARE EXPERIMENTING WITH A POSSIBLE KEY TO ANOTHER WORLD.

Will We Talk *to* the Dead by Radio?

By HEREWARD CARRINGTON, Ph. D.

The author is one of the most widely known figures in the field of psychic phenomena both here and abroad. Whether or not the reader believes that a separate spiritual world exists—a point which Dr. Carrington neither affirms nor denies—the fact that unexplained energies are being recorded on sensitive radio apparatus makes the author's laboratory work significant insofar as it promises to open up realms now closed to us.—Editor.

WILL it be possible in the near future to send wireless messages, or establish some analogous mode of communication with the spirit world—as many advanced psychic students believe?

Recent remarkable advances in wireless, on the one hand, and in psychical research on the other, would seem to indicate that something of the sort is not beyond the bounds of possibility. If we assume the existence of some spiritual world, it is entirely possible that some such mode of communication will be established.

Marconi and numerous other investigators in the realm of pure science have recently stated that they have received consecutive and systematic radio impulses which they cannot account for and the origin of which yet remains a mystery.* They are inclined to believe that these radio impulses emanate from beings that live upon some other planet, and who are attempting to communicate with us in this manner. Certain it is, they claim, that these messages do not originate upon our planet, as no sending apparatus yet devised by man is capable of transmitting the enormous wavelengths which they have been enabled to catch and detect. And it seems certain, also, that these messages are too regular and systematic to be attributed to any freaks of nature, such as sun spots or atmospheric electricity. It is not irrelevant to call attention to these so-called "messages" in the discussion of the attempted modes of communication by means of ordinary radio apparatus, the details of which are familiar to all experts.

In considering the possibility of intracosmic communication through the medium of highly sensitive instruments, it is necessary, first of all, to remove from one's mind certain prejudices in order that the ground may be cleared for the reasonable discussion of the possibility of communications of this character. The foremost obstacle which arises concerns the actuality of any such spiritual world.

Is there or is there not a spiritual world?

The sceptic answers no; he denies the possibility of its existence, upon scientific grounds. If his contention is correct, if no spiritual world exists or can exist, then any mode of communication with it is obviously impossible.

On the other hand, it must be accepted that there are forces at work about us that have not yet been analyzed or understood—forces that science may some day measure.

For example, we can sense even if we cannot see another individual's mind or ego.

How do we know that a mind exists in the person to whom we are talking? Only by the evidence of those senses by which it communicates with our own mind.

How do two minds ever communicate with one another? They communicate in three ways, and in three ways only:

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* See "Are We Getting Radio Signals from Another Planet" in POPULAR RADIO, May, 1922.

(1) By means of air vibrations—speech;

(2) By means of marks made upon paper—writing;

(3) By means of certain bodily movements—sign language.

Only by these methods do we get into contact with other minds; hence by common agreement we infer their presence because they react in the same way that we would to these various stimuli.

But these modes of communication are all symbolic and more or less imperfect. No one of them conveys the full meaning of the thought, and it is the experience of almost everyone that he can never fully express and convey to another person precisely what he feels and thinks. Therein lie the imperfections of our transmitting and receiving apparatus.

It seems reasonable to conclude, therefore, that there is a real world which is unseen and in a large measure as yet unsensed. It is, in fact, the more real world than the purely physical world we know. It is the world of thought, of mind and consciousness. It is, in short, the spiritual world, in which we habitually live even while in the body; it is certainly real to us, even though it is never directly seen by any of our senses while we are inhabiting physical bodies. Nor has this world as yet been registered upon any delicate recording apparatus which has been devised.

Granting the reality of such an invisible world, therefore,—a world of mind and consciousness—the question arises: Does this world continue to exist after the destruction of the physical body?

All religions, of course, answer this question in the affirmative; the tendency of modern physical science, on the other hand, is undoubtedly to answer in the negative. The attitude assumed by the psychic researcher is that the question resolves itself into a matter of evidence—a question of fact. If such a world exists, it should be capable of proof. And certain psychic phenomena seem to offer proofs that some such world exists, and under certain conditions it is capable of contacting with our physical world.

Assuming some such world does exist, how are we to conceive any method of communication with it? Recent researches indicate that thought is dynamic. The activity of the mind does actually modify the ether and send forth definite vibrations, not unlike radio impulses which are capable of registration. Dr. Baraduc, of Paris, has succeeded in obtaining a number of curious photographs of what appear to be etheric swirls, which he claims were generated by a series of definite thoughts and emotions. In other words, he had succeeded in photographing the dynamic action of thought. It seems reasonable to suppose that when thoughts are created they should generate etheric activities, just as they are known to create or coincide with definite physical, chemical and electrical changes, which have been determined and registered.

If thought, then, can modify the ether in some such manner, it is equally reasonable to suppose that some day an instrument will be devised which will be capable of detecting and registering these impulses, just as we have already devised receiving apparatus for the detection of the gross etheric waves which are sent out in wireless telegraphy. All that is needed to accomplish this is sufficiently poised and delicately attuned recording apparatus.

Could we but find an energy common to the two worlds—the physical and the spiritual—we should have here a medium of direct communication between them, possibly by instrumental means. It is conceivable that such an energy might be manipulated, or controlled, by means of thought; it is equally conceivable that this energy might also be detected by means of delicate instruments yet to be devised. This action and interaction might not even be direct; it might be indirect. By means of a series of intermediaries one slightly more material than

Will this resonance coil indicate the presence of invisible visitors?

From a photograph made for Popular Radio

If a human being approaches this coil, the variations of the current flowing through it are immediately recorded. If, during a seánce, no living being is near this coil yet some unseen energy is recorded, may not these unknown presences indicate some heretofore undiscovered psychic forces?

the last we might obtain a continuous series of connections from an immaterial to a material sphere.

The Gnostics, as we know, held this view; their "demons" corresponded to the "Ten Intelligences" of the East. The Gnostics held that matter and spirit could have no intercourse—they were, so to speak, incommensurate. Granting this premise, how was Creation possible? Their answer was a kind of gradual elimination; God created an æon; this æon created a second æon, and so on until the tenth æon was sufficiently material (as the Ten were in continually descending series) to affect matter, and so brought about the creation by giving to matter the spiritual form.

We have an analogy for this in modern physics. In electricity, the "relays" aptly illustrate the principle here outlined. In working over long lines, or where there are a number of instruments in one circuit, the currents are often too weak to work the recording instruments directly. In such cases there is interposed a "relay" or "repeater." This instrument consists of an electromagnet, around which the line current flows; the delicately-poised armature of this relay, when attracted, makes contact with the local circuit, in which a local battery and the receiving Morse instrument are included. The principle of the relay is, then, that a current that is too weak to do the work itself may get a strong local current to do its work for it.

If this be true, it is certainly conceivable that spiritual beings, if such there be, might be enabled to manipulate a delicate energy of some sort which in turn would liberate a stronger energy, and so on down the line until an energy is liberated that is capable of being re-

A FACE FROM ANOTHER WORLD

An actual photograph made by Dr. Geley, of Paris, in 1909, of a materialized spirit face in formation, showing the unused visions substance called "ectoplasm" as it was issuing from the famous medium "Eva". If the camera can record such phenomena, may not the infinitely more sensitive radio apparatus perceive heretofore unrecorded impulses from an unknown world?

corded by delicate physical instruments. If, as now seems certain, the human will is a dynamic energy, and thought can impress the photographic plate, it is certainly but a step from this point of development to existing physical apparatus that is so delicate that it can register the heat of a candle at a distance of a mile and a half (as does Langley's bolometer), or measure the temperature of stars distant from us many millions of miles in space and invisible to the naked eye. The step seems but a short one indeed!

Theoretically, therefore, it seems well within the bounds of possibility that some such common energy will one day be discovered, and that some mode of instrumental communication will be established between the material and the immaterial worlds—if the latter exists.

It is the purpose of the present experiments to show only that it is scientifically possible, and that, once granting its possibility, actual communication with that world may conceivably be established by means of delicate instruments which may be devised. Certainly if such communication were ever established, it would at the same time prove the reality of such a world, simply by reason of the communication which had been established with it.

Will such an instrument be devised? It seems possible to many that science is on the verge of this discovery—a discovery which, if made, would profoundly affect our science and our philosophy, and would prove an epoch-making event. At this moment, all sorts of energies are passing through the room in which you, the reader of these lines, are sitting; they are passing through your own body, even though you are not in the least aware of it—gravitational, magnetic, electric, and other forms of energy of which you are entirely unconscious. Yet, as you know, you have merely to set up a simple piece of radio apparatus upon the table in front of you, and immediately some of these energies are caught and registered. All through the ages, electric waves have existed, but it has remained for the present generation to detect them. As soon as the suitable piece of apparatus is set up and properly attuned, your messages are recorded.

It seems rational to suppose that the human brain is in itself a detector of such impulses and that it acts as such when telepathic messages are transmitted from one mind to another. The analogy between wireless and telepathy has, of course, been urged in the past by several competent investigators: Sir William Crookes went so far as to postulate a definite range in the scale of vibrations within which telepathic or thought-waves might actually exist. It must be said, however, that as yet no conclusive evidence has been brought forward to show that telepathy is actually vibratory in action. Some investigators, indeed, have claimed that just as gravitation holds together all the matter in the universe, so there may be a form of "spiritual gravitation," uniting life and life, throughout the Cosmos. Professor T. J. J. See has, however, put forward the theory that gravitation itself is an electromagnetic phenomenon, and, from the physical point of view, it seems incredible that anything could be transmitted from brain to brain without the intervention of some mode of vibratory activity yet to be determined.

This is, in fact, one of the problems upon which the investigators are at present engaged in the American Psychical Institute and Laboratory in New York. They are trying to discover the actuality and nature of thought-waves, and to register and record them upon suitable instruments. They believe that they have already made progress in this direction, and that they are on the verge of important discoveries. They have devised certain delicate pieces of apparatus which apparently register the dynamic action of thought and show the definite physical pressure of the human will. And, among other experiments, they are making the following tests which any one may duplicate:

In wireless telegraphy, "carrier waves" are sometimes employed—that is, continuous waves, the frequency of which can be accurately registered. Upon these can be sent "superimposed" waves, usually much longer than the first. The carrier waves seem to have the faculty of carrying along and reinforcing the superimposed waves. Investigators at the Psychical Laboratory have, therefore, conducted a preliminary series of experiments in telepathy, by placing both subjects in a high-tension electric field, through which electric waves of definite frequency were passing, and which acted as carrier waves. The purpose was that, by this means, they could reinforce and detect telepathic waves, transmitted between one brain and another. While they cannot publish any definite conclusions at the present time, they have apparently attained some striking results, which they hope to co-ordinate and publish shortly.

What is the purpose of the Psychical Laboratory? To pursue psychical research by means of laboratory experiments, conducted by qualified investigators with the aid of suitable and delicate apparatus. Many laboratories exist, of course, for the investigation of physical, chemical, astronomical and other sciences, but nowhere has there been a laboratory devoted exclusively to the exploration of the psychic realm; this is the first laboratory of this kind in the world. Within its walls are being conducted experiments which may help in the solution of a number of psychic problems. The investigators have also devised a number of instruments which are intended to record the presence of invisible energies, should they exist, and these are now being experimented with upon an extensive scale.

It seems possible, as the result of these and other researches, to believe that there is more than one ether; that there may be, in addition to the physical ether that we know and in which modern science believes, another ether—for the reality of which a number of writers have in fact contended. This has been called the "mentiferous ether," or, the ether which conveys thought-waves, and which is utilized by nature for that express purpose. Occult science has, indeed, contended for many years that there are four ethers—only the lowest of which is as yet known to the physicists. While I do not defend this view, nevertheless, there is something to be said in its favor. Certainly what may happen in these various ethers is of the greatest interest.

¶ *IF telepathic impulses may be recorded between two living persons—as science states is possible—may we not some day devise instruments so delicate as to record similar impulses from the dead? In the next issue—July—Dr. Carrington tells how these experiments are being conducted.*

Ships *that* Steer

By ROBERT G. SKERRETT

© International

FOG and fire are the two dangers most dreaded by the modern mariner. However, the power-driven steel ship has less now to fear from internal flames because of her pumping facilities and the ability to flood at will the compartments that are menaced.

But the perils of "thick weather" still persist.

Blanketing banks of fog, obscuring curtains of snow and veils of pouring rain all too frequently lower the visibility of navigational marks and beacons and arouse anxiety in the man upon the bridge when steering his vessel toward a dangerous coast.

More craft are wrecked or lost by reason of fog than through any other condition of the weather. Thousands of lives and millions of dollars worth of property are thus sacrificed annually. Sudden temperature changes will turn the clear air above the water into an enshrouding mist, and the seafarer may find his objective shut out from view when the way ahead of him seemed plain sailing. A slight deviation from a prescribed course may make all the difference between safety and disaster.

Day or night, fog is ample reason for alarm, inasmuch as it is so easy for the navigator to make a mistake when groping onward toward his unseen haven. Lighthouses and lightships are no less essential as guides while the sun is above the horizon, and when these nautical mileposts, so to speak, are no longer visible, treacherous currents may swerve a vessel from the path of secure advance.

To meet these perils, the radio engineer has recently devised apparatus which rob thick weather of much of its lurking hazards. It is known as the "radio compass."

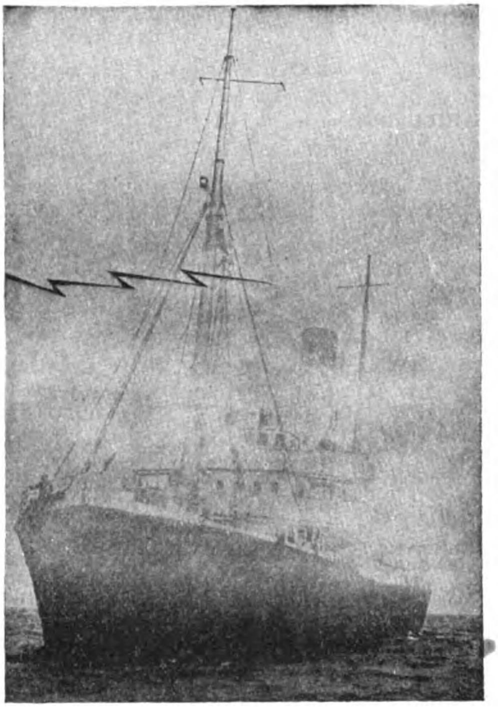
The radio compass is the outcome of radio phenomena which the man of science has turned to good account. Fully a decade back it was noticed that radio signals had a directive element; that is, they were heard loudest along a certain line when the receiving instruments were swung through an arc. Accordingly, during 1916 and 1917, arrangements were made by the U. S. Lighthouse Service and the Bureau of Standards for experimental tests between ship and shore stations for the purpose of devising some form of radio control. Those researches gave promising results, but the work was halted when the country entered the World War.

During the period of conflict, the radio experts of the U. S. Navy evolved a type of radio compass, and they established a large number of shore stations to help such ships off the coast as were already provided with radio signalling equip-

by Sound Waves

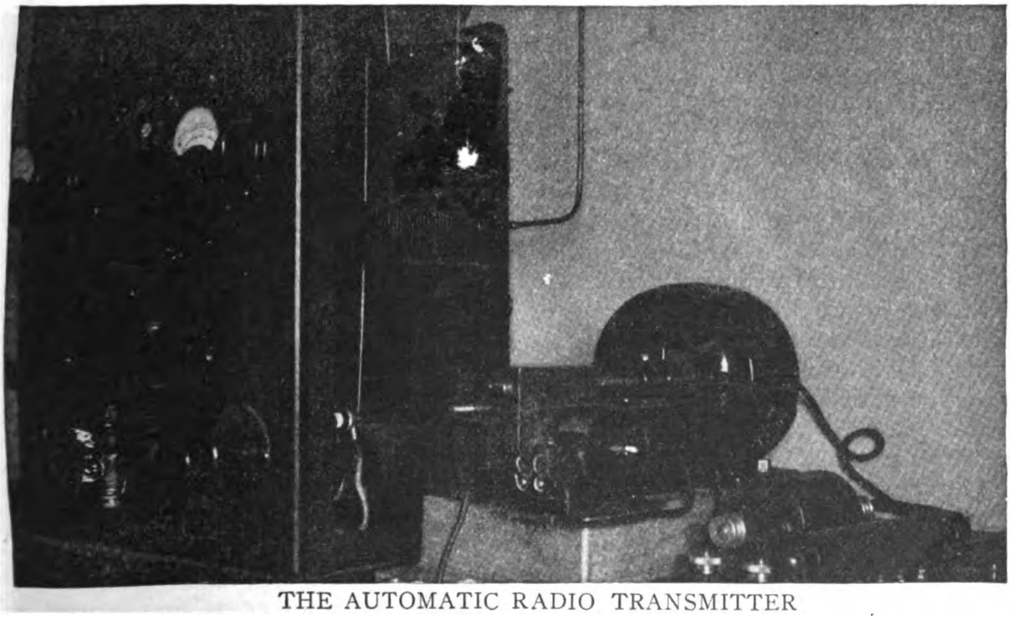
The Radio Compass, the Latest Device of Science for Overcoming the Mariners' Oldest of Enemies—Fog

ment. The method consisted of an exchange of signals between the distant craft and one or more land stations, where, by radio cross-bearings, the vessel's position was determined and the information transmitted to her. To be effective, the inquiring ship had to have someone aboard who was capable of both sending and receiving radio code-signals. The system adopted by the Lighthouse Service operates differently, and the mariner himself ascertains the location of his boat; it is not needful for him to send a radio signal to do this.



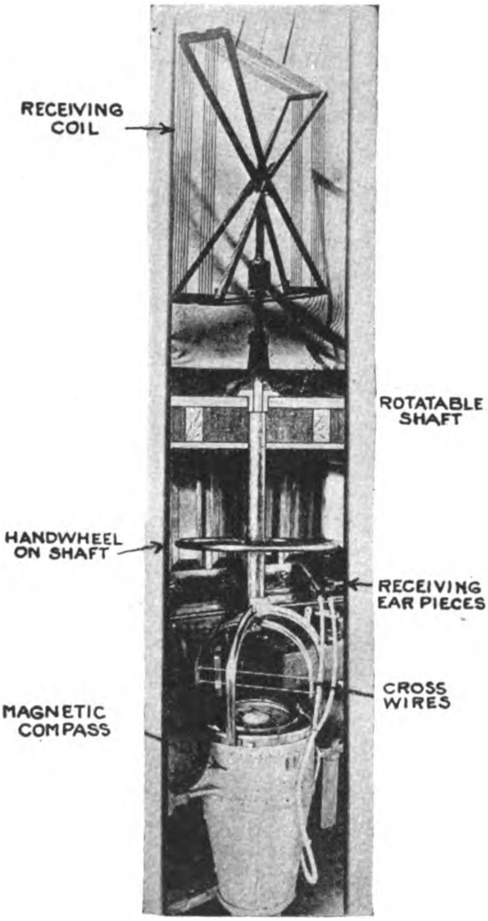
International

As long ago as 1888, the German physicist Hertz made use of a coil for determining the source or direction of arriving radio waves, and the radio compass produced by F. A. Kolster of the Bureau of Standards is based upon a kindred sensitive or responsive element. His coil aerial is nothing more complex than ten turns of wire around a rectangular frame about four feet square. This



THE AUTOMATIC RADIO TRANSMITTER

This is the type of apparatus that is installed aboard lightships and light stations.



A cross section through the chart house of a lighthouse tender equipped with a radio compass receving outfit.

frame is carried by a rotatable shaft. When the coil lies parallel with the path of the on-coming radio waves the signals received can be heard loudest, and when the coil is at right angles to the radio waves the signals are faintest. Therefore, all that the listener has to do is to swing the frame until the tell-tale dots or dashes are strongest and clearest. At that moment the pole of his coil is pointing directly at the sending station.

So far, so good, but this in itself is not enough to put the seafarer out of danger. This is how the device works from this point:

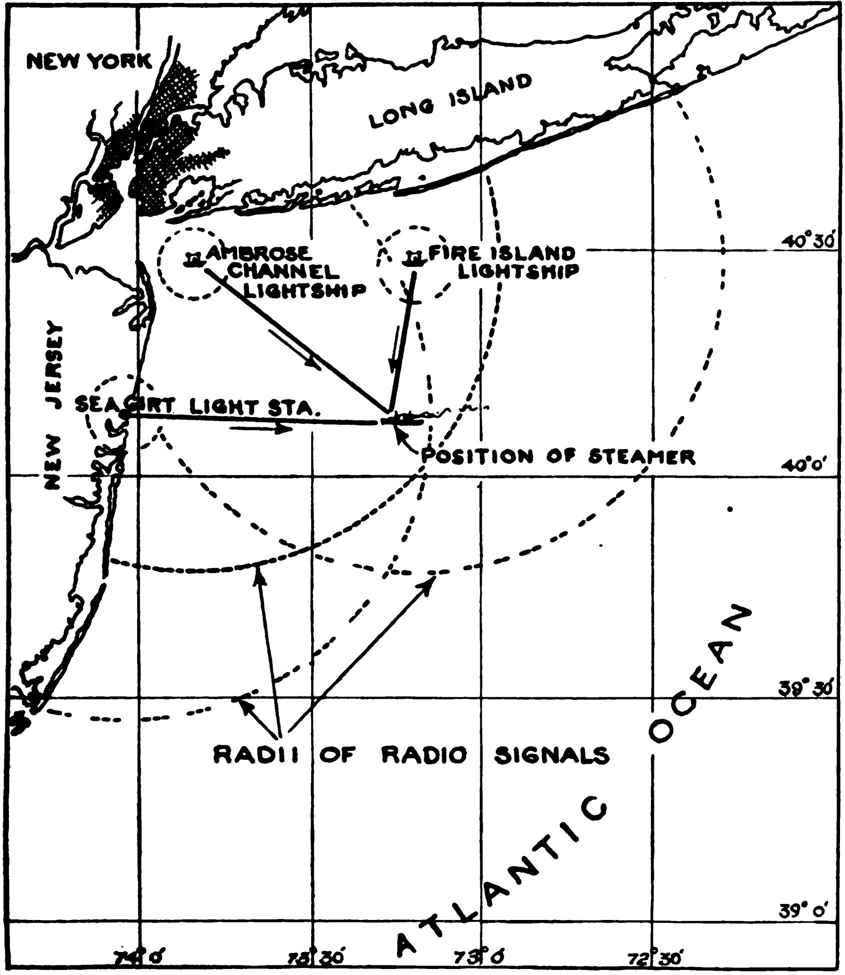
Suppose the fog-bound ship is traveling due north and that the signals are sharpest when the coil is on an east-and-west line. How is the operator to tell whether the transmitting station is off to the right or to the left of him? This knowledge is essential to his safety; he must not steer toward the open sea when his objective is in the opposite direction. In its initial form, the Kolster radio compass was deficient in this particular, but it has been modified by the addition of what is termed a unidirectional feature. This simple attachment makes it practicable to pick up a signal's maximum intensity only when a marker is pointing right at the generating station.

Two parallel wires set one above the other and supported by a U-frame attached to the lower end of the rotatable shaft and suspended immediately above the magnetic compass, enable the man at the helm to compare the course of his vessel with the direction whence come the guiding radio signals. This information, however, while helpful, does not give him his distance from the sending station, and this he must have so that he may head his ship toward his unseen goal without fear of running upon intervening or submerged obstacles. Therefore, radio signals have to be picked up by the navigator from a *second* station, and its bearing also checked by the magnetic compass. When a line is drawn on the chart from each of the two stations, which agree with the magnetic-compass readings, the off-shore point of intersection of the two lines indicates the geographical position of the groping craft. This is made plain in the accompanying diagram. It is a simple matter of triangulation-nautical surveying.

While the fundamental principle of the radio compass has been known for more than three decades, much study has been required to bring the apparatus to its present dependability. Nearby wiring, rigging, smokestacks, ventilators and steel masts induce what is called "re-radiation." These "radio echoes" of primary radio waves at first caused a good deal of confusion to the listener at the radio compass. Researches by the U. S. Bureau of Standards have shown how this source of error can be neutralized; and a radio compass can now be calibrated to offset these disturbances just as a magnetic compass can be compensated against the effects of neighboring masses of iron and steel.

The ordinary telephone receivers, if used by the operator of the direction finder, would be apt to deflect the needle of the magnetic compass if brought close to that instrument. To prevent this, a special radio receiver is located at a little distance from the magnetic compass, and the signal sounds are conveyed through rubber tubing to the ears of the man at the radio compass.

The radio transmitting apparatus built for the U. S. Lighthouse Service is designed to operate automatically; each set propagates a series or a group of distinctive signals. This is indicated on the map drawing that illustrates the three radio-sending installations adjacent to the entrance to the port of New York, at Sea



HOW RADIO SIGNALS DETERMINE A SHIP'S POSITION

This diagram shows the radio-compass stations at the approach to the port of New York. Each station sends out distinctive signals; by taking radio cross-bearings from two or more of the stations, a ship nearing the coast can determine her position even though the lightships and the lighthouse are invisible.

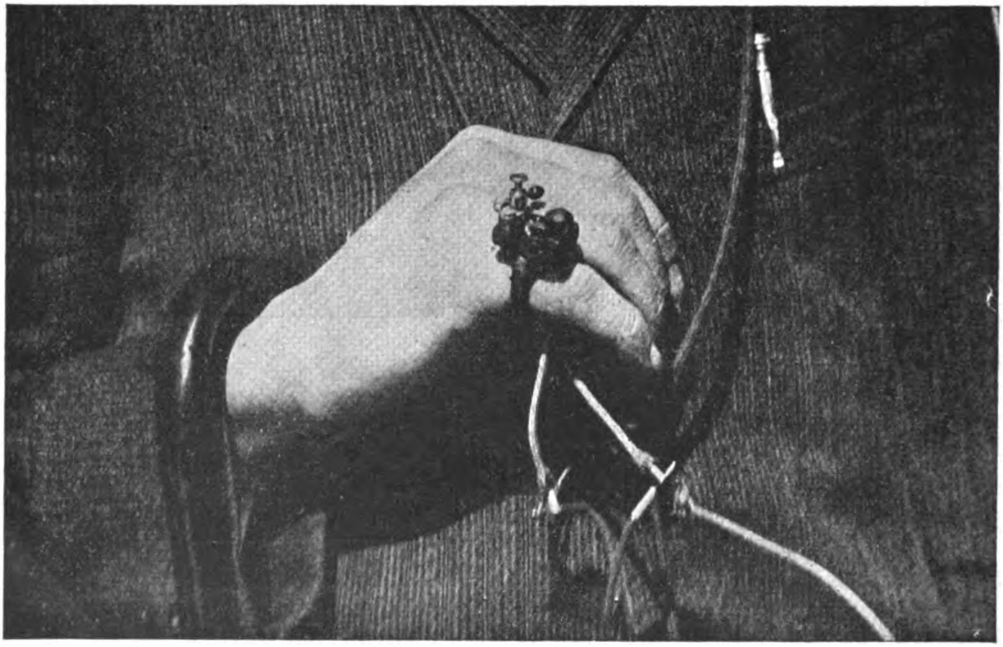
Girt, New Jersey, and also aboard the Ambrose Channel and the Fire Island lightships. In addition to the characteristic signal of each generating unit the tone of each signal is sufficiently individual to prevent confusion.

A number of lighthouse tenders now carry radio compasses, and their skippers have repeatedly demonstrated the value of these aids when traversing the waters in the vicinity of New York during the prevalence of a fog. On a run of about forty-three miles, for example, the tender *Tulip* was directed entirely by radio compass. While her commander was not very familiar with the use of the instrument he was able, nevertheless, to bring his boat within 800 feet of Fire Island Light Vessel, which was his objective. He did this with but three readings of the radio compass, and the last of these was taken when the tender was fifteen miles away from the lightship.

The advantages of the new system of guidance have been summed up thus:

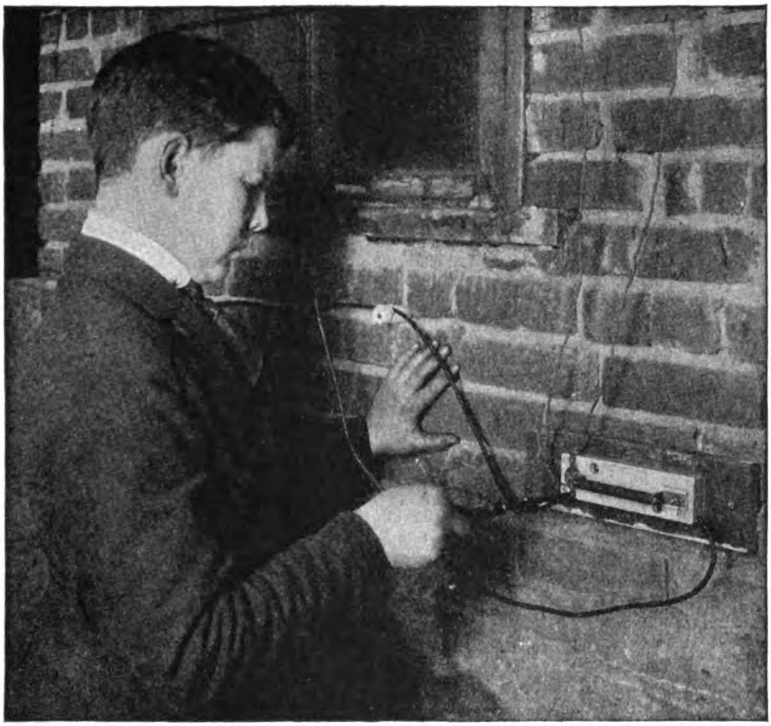
1. The navigator may obtain bearings himself, and is not dependent upon others for the accuracy of the results.
2. Any number of vessels may obtain bearings simultaneously and as frequently as they desire without interfering with one another.
3. No knowledge of radio telegraphy is necessary on the part of the radio-compass operator.
4. Transmitting stations, being automatic, may be supervised by the employees of existing lighthouses or light vessels. No additional personnel is needed.
5. The direction finder aboard a craft may be used for locating at sea other vessels that are transmitting signals, and this may be a means of preventing collisions in times of thick weather.

Experience up to date warrants the belief that the radio compass will do much to rob seafaring of some of its hazards and that it will go a long way toward reducing yearly the number of catastrophes due to low-visibility. The general adoption of the radio compass would appear to be inevitable.



Underwood & Underwood A RADIO RECEIVING SET IN A FINGER RING

This tiny apparatus was built by Alfred G. Rinehart; it measures an inch in length, five-eighths of an inch wide and seven-sixteenths of an inch thick. An umbrella is used as a ground.



Westinghouse

BE SURE THAT YOUR LIGHTNING ARRESTER IS IN ORDER

One of the several devices prescribed by the National Electric Code as a protection against damage caused by the electrical disturbances that would otherwise make thunder storms a source of peril to the radio amateur.

How To Use Your Radio Set in Summer Time

Practical Pointers and Helpful Suggestions for the Amateur

BY PIERRE BOUCHERON

THOSE who have spent so many evenings this spring listening-in to the entertainments of the broadcasting stations need not miss their radio programs during the evenings of their summer vacations. They may carry their receiving sets away with them—even into the wilderness, provided, of course, that the distance from the broadcasting station is not too great.

It is a simple matter to make up or purchase a portable set, complete in every detail, which can readily find room in a suitcase. Indeed, it has been the custom of boy scouts, campers and other radio enthusiasts for several years past to include the radio set on their summer trips. No matter where you may be located—at sea-shore or in the mountains—devotees of the Hertzian art may always be in touch with the world's affairs.

Now that the broadcasting station has become capable of sending out more entertainment and educational features than even the country's most complete vaudeville circuit has ever been able to devise, summertime radio takes on a new significance to lovers of the great outdoors.

The average vacationist, familiar with the broadcasting service, need no more think of leaving out the portable radio receiving set than he will leave out his razor or his ever-ready camera. As a matter of fact, the portable receiver does not need to take up much more room than the ordinary box camera; indeed, radio is somewhat analogous to the camera and the phonograph in this respect. Many campers who formerly took along the phonograph will want to take the radio receiver instead.

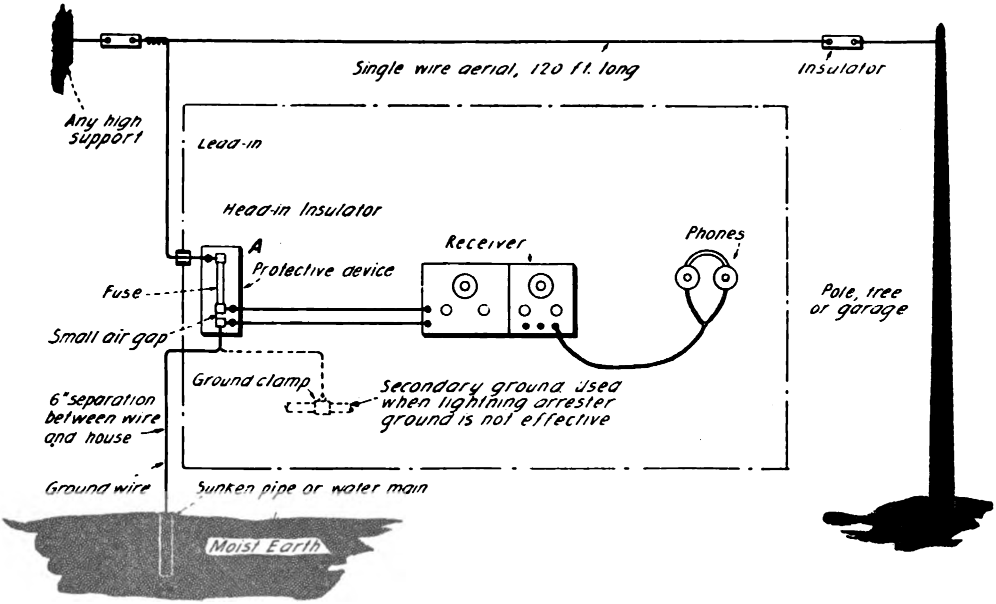
Perhaps in a short time, the summer resort drug stores and candy counters will carry spare vacuum tubes, batteries and phones, in much the same way that they carry films and other camera supplies today.

Summertime radio is sure to become extremely popular. It offers a service unparalleled in its scope and usefulness. The vacationist has at once the news of the day, weather reports, music, lectures on the how-and-why of camping and what not. It is assumed, of course, that the prospective radio-vacationist locates at a point not too remote from the nearest broadcasting station, otherwise he cannot hope to secure good receiving results. In general, the details of erecting a portable radio receiving set are the same as those applying to city operation, except that it is perhaps not necessary to make permanent antenna and ground systems. A 125-foot wire stretched between two nearby trees for antenna, and a piece of pipe sunken into moist earth or dropped in an adjacent pond or stream, will form the ground.

Aside from the outdoor use of radio during the summer months, there are some important protective details which must be followed by the broadcast enthusiast, no matter where the set is located, when he employs an outdoor antenna.

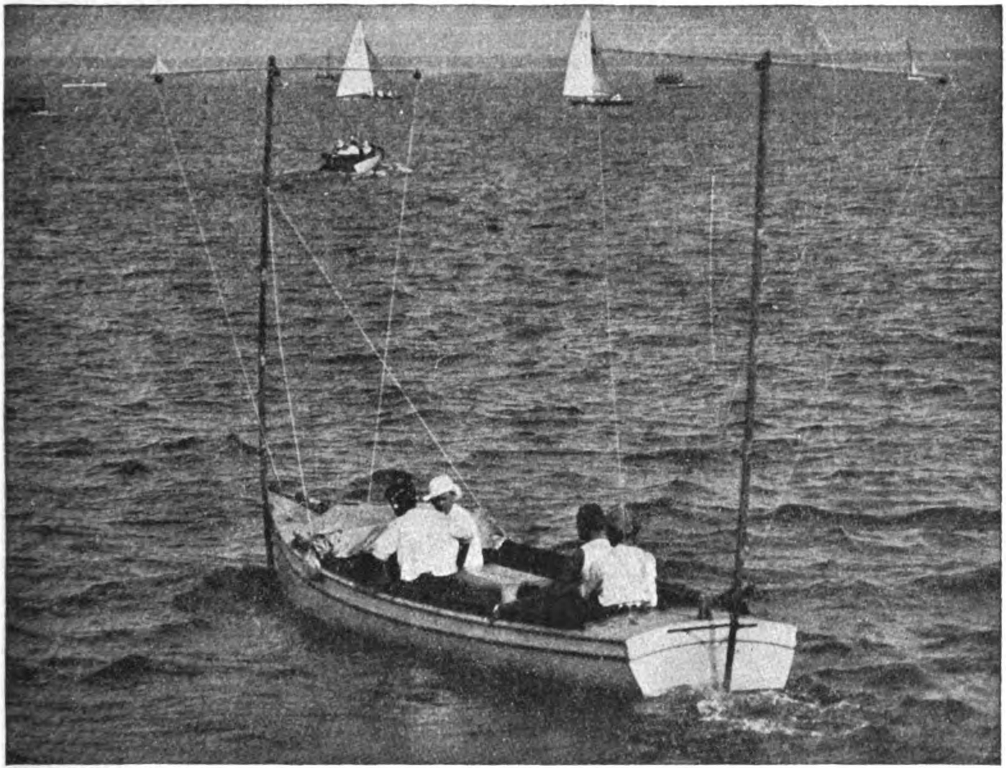
How, for instance, can he protect himself from lightning?

First of all by equipping his receiving set with a suitable lightning arrester. This is nothing more than a simple device


Single wire aerial, 120 ft. long
Insulator
Any high support
Lead-in
Head-in Insulator
A
Protective device
Receiver
Phones
Fuse
Small air gap
Pole, tree or garage
Ground clamp
Secondary ground used when lightning arrester ground is not effective
6" separation between wire and house
Ground wire
Sunken pipe or water main
Moist Earth

HOW TO MAKE YOUR RADIO SET SAFE AGAINST LIGHTNING

This shows the general arrangement of the antenna and the receiving instruments; note how the lightning arrester should be connected up and the methods both of grounding the set outside the house for protection against lightning and also inside the house for operation. For efficient reception two points should be kept in mind; high supports for the antenna and a good solid ground for operation.



Underwood & Underwood

A PRACTICAL TRANSMITTING SET ON A LAUNCH

This radio outfit was actually used last summer for reporting an international yacht race for the Royal St. Lawrence Club trophy. The set was operated on a current produced by a hand-driven generator.

similar in appearance to the plug fuse used in electric light circuit, and the National Electric Code insists that such device be employed in connection with receiving antennae. This rule is somewhat the same as that which applies to protective devices for regular land telephone lines, telegraphs, fire alarms, and other signal systems. The arrester is really a simple appliance and is usually furnished with receiving antenna equipment with full directions for installing. There are two general makes:

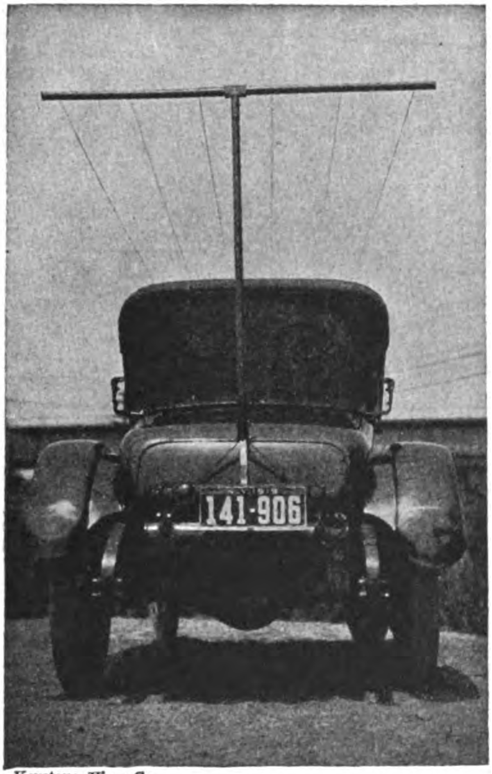
The *vacuum* type.

The *fuse* type.

The function of the lightning arrester is to divert to ground the heavy electrical charges picked up by the aerial during a local thunderstorm and thus protect the receiving instruments. In other words, the arrester drains off excessive charges from the receiving circuit. In general, there is no more danger of an actual bolt of lightning striking the aerial than in striking an ordinary telephone or telegraph line. It is the heavy inductive effects induced in all metallic conductors by lightning which may damage the delicate receiving instruments or possibly shock the operator.

A safe plan is further to protect the radio installation by grounding the aerial at each approach of a thunder-storm. This is best done by installing a large size single-pole, double throw switch outside of the house where the aerial enters.

The ground lead should consist of as heavy a wire as possible; in fact it is understood that the new regulations governing receiving aerials will recommend



Keystone View Co.

A TRAVELER'S SET *DE LUXE*

A radio receiving and transmitting equipment that has been put to practical purposes by an experienced amateur who used it for both telegraphing and telephoning while on tour.

No. 14 B & S wire gauge leading in as direct a line as possible to a spike or pipe five or six feet long firmly driven into the ground. The heavy wire and the spike must be erected and insulated so as to have at least six inches clearance from the walls of the house. This ground, while serving well as a "drain" for heavy electrical charges need not necessarily be the one used for actual receiving, in fact it is not recommended, for a pipe driven into the earth, unless the earth is damp and soft, will seldom prove effective. It is sometimes better to obtain the receiving ground by a permanent connection to the water mains as is done by telephone line constructors. In this connection, the ground clamp furnished with most outfits is especially useful.

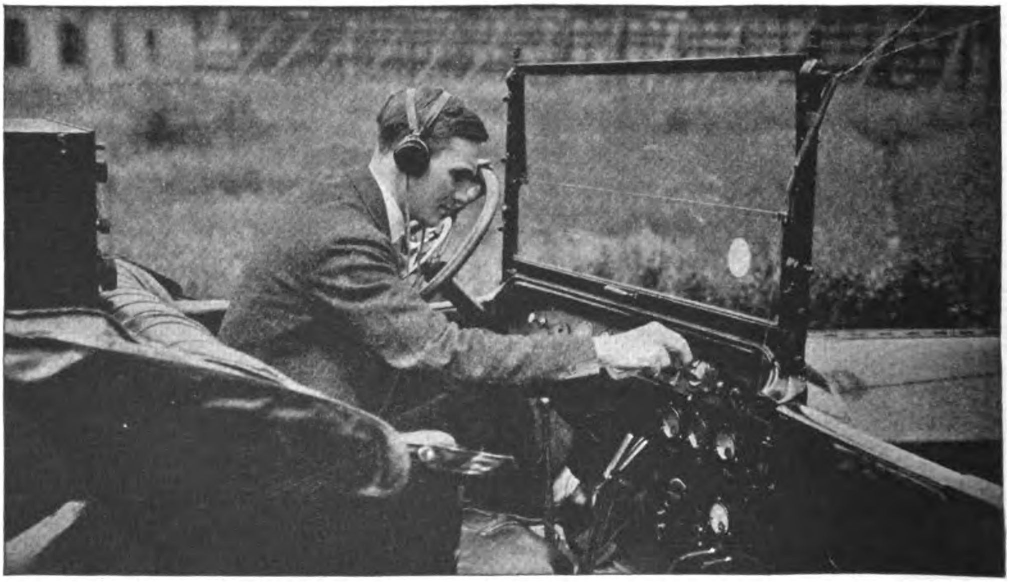
The necessary parts for the complete antenna and ground system may be listed as follows:

The Aerial

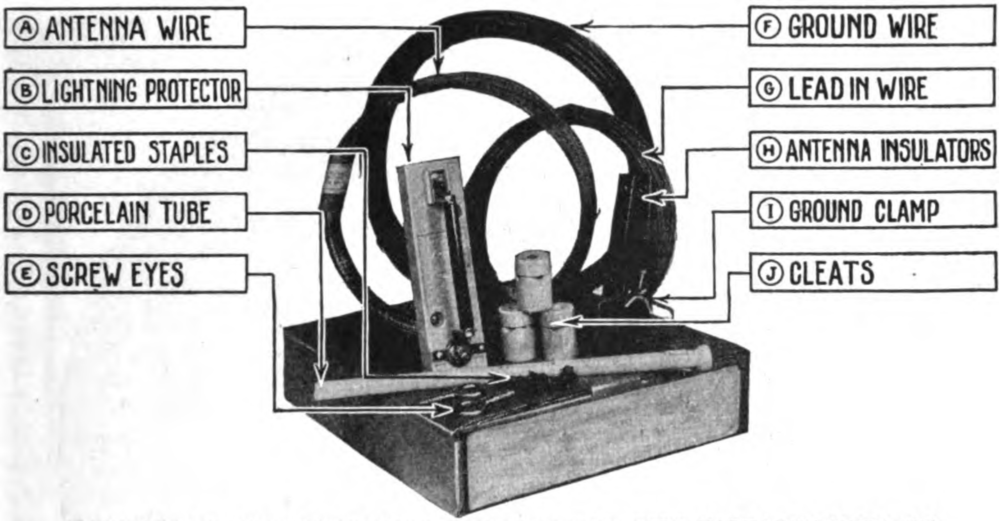
1. From 100 to 125 feet of No. 14 copper, bare copper clad, silicon bronze or aluminum wire stretched horizontally about 35 feet from the ground and provided with a suitable lead-in wire about 25 feet long.
2. Two antenna insulators.
3. A lead-in bushing insulator.

The Ground

1. Not more than 50 feet of heavy insu-



Keystone View Co.



THE COMPLETE EQUIPMENT NEEDED FOR THE INSTALLATION OF AN ANTENNA

Be sure that it includes a lightning protector—or you will not only expose the house to fire from thunder bolts but also you will violate a law that is designed to safeguard radio operators.

lated copper wire not smaller than No. 14 B. & S.

2. A number of porcelain or glass insulators to guide the ground wire to the nearest connection.

This ground is in reality of the "lightning rod" type and, therefore, should lead to earth in as direct a manner as possible.

If under operating conditions it is found that the ground obtained by sinking a pipe into earth is not entirely satisfactory—that is to say, that the signals are not as strong as they should be, all things being equal—then the ground pipe is probably making a poor earth connection, owing to the dryness of the soil. This may be remedied by the simple expedient of connecting another wire from the lightning ground to an adjacent water or steam radiator pipe system pipe. This is illustrated in the diagram.

Then again if the radio amateur is located in the country with no water main available, he must resort to an earth ground, after all. In this instance it will be necessary to sink the pipe length as deep as possible and until moist earth is reached, which is essential to make a good radio ground.

Briefly it may be said that summertime radio is no more dangerous than land line telephony, providing one installs the necessary lightning arrester device mentioned here. Of course, atmospheric disturbances are much more frequent and of greater intensity during the summer months than at any other time of the year, and this sometimes results in noisy operation. Under such conditions one must be patient and not expect too much of radio—it is not fool proof. As a matter of fact, radio broadcasting is still in the experimental stage; indeed, it has been said that every broadcasting station in the country is in reality a research laboratory. New facts are being discovered each day and the art is progressing more rapidly, perhaps, than any other branch of science has ever been known to do.

¶ *DO your know the code? Are you thinking of learning it? In the next number—July—an experienced radio operator will tell the best way of mastering it—and point out the wrong ways.*

From a photograph
made for POPULAR RADIO

The "MAN IN THE MOON"

The Real Story of the Miracle That Gave Him Speech—and If You Don't Believe He Can Talk, Listen in on Tuesday and Friday Night at Seven o'Clock

By HOMER CROY

> Dear Man in the Moon: I am a little boy nine years old and I listen on my wireless every night you talk. As we have numerous stars shining over our house, I wish you would name one of them after me. My house is on the corner of John Street and Franklin Avenue.
>
> —HAROLD A. HERBERT

THAT is the way the letters are coming in to the Man in the Moon. Little Harold was so anxious to have a star named after him that he went out and looked up and sure enough—right over his house—there were many stars shining. So Harold wrote the great and wonderful Man in the Moon and told him exactly where his house was located.

This great and wonderful man, who is known to thousands of children, lives in Newark, New Jersey. Twice a week he gives children the newest and most successful kind of juvenile entertainment—a bed-time story by radio. Tonight thousands of children will want to hear what the Man in the Moon has to say, and when he comes away down from the moon and talks to them in their own home they will be as happy as only children can be.. One mother wrote in that her little girl—we will call her Sarah Smith—would not eat her oatmeal and could the Man in the Moon help her out? That night the Man in the Moon spoke into the transmitter:

"Is Sarah Smith listening? Well, the Man in the Moon wants to tell Sarah that she must eat her oatmeal if she wants to grow up to be big and strong. That is what the Man in the Moon says to Sarah."

A few days later the Man in the Moon received a letter from the girl's mother saying that Sarah was practically living on oatmeal!

That is how impressive the radio is to children. Thousands of letters pour in from children. In fact, the Man in the Moon has received as many as 1,800 letters in one week.

Who is this Man in the Moon who is bringing joy into the lives of so many children? Where is he? And what does he do between moons?

This is where the disillusioning part begins. He is William F. B. McNeary—a bachelor. But we mustn't hold that against him. For that matter, so is Santa Claus. The Man in the Moon, in real life, is the last person in the world that you would ever think of as being the greatest radio story teller for children. To part the curtains a little more: a person would probably think of him as being a kindly old gentleman walking slowly down the street, cane in hand, possibly on his way to feed the pigeons; but this is not the Man in the Moon. No indeed. Instead of that he used to be a detective.

During the war he was in Russia and Poland in the United States intelligence service—and it is due to that fact that we now have the Man in the Moon stories. It came about more by accident than anything else. In Poland he was living with a Russian family, and in the family was a daughter who could speak fluent English. She used to tell Mr. McNeary fairy stories and folk stories that her nurse had told her. These stories interested Mr. McNeary and he encouraged her to tell him more. And so she did. After a time he came back to the United States and, severing his connection with the intelligence office which he had joined as a war time measure, looked around for a job, as so many men had to do on their return. One evening he went to visit a friend near Newark who had a radio outfit and McNeary was invited to listen in. He knew nothing about radio. With idle curiosity he put on the headpiece.

"Who wants to buy a variometer? Who wants to buy a variometer?"

That was all he could hear. He had expected sweet music and instead of that all he could hear was some bug wanting to dispose of his variometer. He kept repeating it over and over and giving his call number. Then suddenly, as McNeary listened, an idea hit him: Why not put a newspaper into the air with all features—news, sports, editorial, comment, fashions—in short, everything from front page to back?

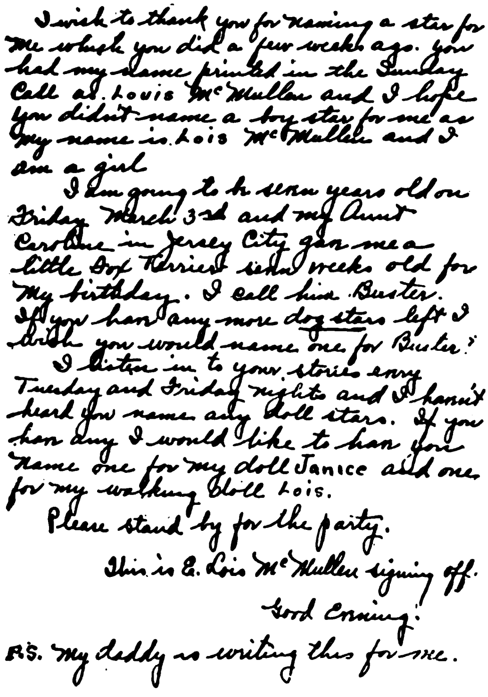
It was a hazy idea, but the more he thought about hooking up with a newspaper with this queer unknown thing called "radio" the better he liked it. Before he had gone abroad for the Government he had been a member of the editorial staff of the Newark *Sunday Call*, so he put up the idea to the editors.

But how could they send messages? Where could they be sent from? How much would it cost? He had about as much idea as the man in the moon. But the paper was interested. So he took his idea to the Westinghouse Company in Newark, but it had no sending station; only the one in Pittsburgh. At last a hook-up was agreed upon and the Westinghouse Company established a broadcasting station. He would announce in his paper what could be heard and the night that the company would broadcast it.

At once his talk became a success. Newark became the center of the radio industry. But what to send? That was the question and a stumper it was. At first he sent out weather reports, sermons, news brevities, music records. But the big idea hadn't yet come along.

Then he hit upon the idea of broadcasting a bed time story for children.

The wiseacres in the game nearly laughed themselves sick. Who in the world would want to listen to a silly sandman story? But McNeary stuck to it. By this time he was radio editor of the *Sunday Call,* and found himself put to it for time. But he was not able to get any one else to tell the bed time stories so it fell to his lot to get up one himself. He hadn't the slightest idea for one—and then he remembered the stories he had heard in Poland. He picked out one and then thought of the name the Man in the Moon—and that night he put it on the radio.



I wish to thank you for naming a star for
me which you did a few weeks ago. You
had my name printed in the Sunday
Call as Louis McMullen and I hope
you didn't name a boy star for me as
my name is Lois McMullen and I
am a girl

I am going to be seven years old on
Friday March 3rd and my Aunt
Caroline in Jersey City gave me a
little Fox Terrier seven weeks old for
My birthday. I call him Buster.
If you have any more dog stars left I
wish you would name one for Buster.

I listen in to your stories every
Tuesday and Friday nights and I haven't
heard you name any doll stars. If you
have any I would like to have you
name one for my doll Janice and one
for my walking doll Lois.

Please stand by for the party.

This is E. Lois McMullen signing off.

Good Evening!

P.S. My daddy is writing this for me.

A MIX-UP IN THE HEAVENS

If the Man in the Moon named a boy-star after little Lois—who is a girl—there will have to be a lot of explaining done and the astronomical charts will have to be made over completely.

A few letters came in reply. Next week he tried it again—and more letters came in. Soon his paper was getting more Man in the Moon letters than any other kind.

The first Man in the Moon story was told in October, 1921; after a time their popularity was such that they had to be moved up to two a week, and thus they stand to-day. But soon the supply of Russian fairy stories ran out; McNeary was now busy scratching around getting out his radio department—and yet the stories must be done. Finally arrangements were made for Miss Josephine Lawrence, editor of the children's page of the *Sunday Call,* to write the stories—and thus it is being done to-day. At seven o'clock Tuesday and Friday nights each week, McNeary takes the story in manuscript form, goes to the Westinghouse broadcasting station and there puts it into the air.

Imitators soon sprang up, until now bed time stories are being sent out by eight broadcasting stations in the United States, but Mr. McNeary remains the original Man in the Moon. He has had the title copyrighted so that there is little danger of the moon ever becoming full of men.

Merely telling stories wasn't enough, so another idea struck him. For the children who were good he named a star after them—and that day assured the success of bed time stories by radio.

The children went wild about it. How wonderful it was to think that the man in the moon had named a star after them—and that it would twinkle as long as the child was good! It beat a shoe-horn or a hairbrush all hollow. It became the new way to correct children. Immediately the children fell in with it and the Man in the Moon became a person more wonderful than Santa Claus—for Santa Claus comes only once a year. Now there are

IN ONE WEEK HE RECEIVED 1800 LETTERS FROM CHILDREN

Santa Claus comes but once a year. But the Man in the Moon (alias W. F. B. McNeary) comes by radio twice a week.

From a photograph made for POPULAR RADIO

thousands of children in the United States who, if they had to choose between Santa Claus and the Man in the Moon, would probably give their fond and doting parents a surprise.'

What amusing, ingenuous stories the letters tell! How they reach the heart! We wish we had more space for them, but as we have not we will have to cut them short.

> I am sending you a few lines to ask you if you have three more stars left of which you can name one for me and one for my little sister and brother. My name is Emma Clodius and my sister's name is Hazel Clodius and my brother's name is Henry Clodius.
>
> EMMA, HAZEL and HENRY CLODIUS

What a hurry they were in to write to the Man in the Moon before all the stars were gone!

> I have a little cousin whose name is Peggy Chapman, and she lives in Jersey City. She listens and loves your stories too, just as I do, and she wishes you would name a star for her, but she is so bashful that she wouldn't ask you.
>
> ROBERT STORK

> I have a little sister named Natalie. Would you please name a baby star after her.
>
> NORMA MATTE

> We listen to your stories every Tuesday and Friday night. I live with my grandma on Princeton Street. My uncle has a wireless set and lets me use it. My uncle is fourteen years old.
>
> JENNIE MAY NELSON

> Won't you please name a star after me? It need n't be a very large one, as I am only seven years old. If you have any tiny stars left up there you might name one for my baby sister, Elaine. She can't hear your stories, for she must go to bed at six o'clock, but I know she would like to have a star for her very own.
>
> JANE LORSON

What a wonderful feeling it must be to have a star of your very own!

> My name is William Terry, but I like to be called "Bill Soldier," because I like horses. I am just four years old, but I will be five on August 11th, 1922.
>
> WILLIAM TERRY

What a long time Bill will have to wait to be almost a man—until August 11th.

> My brother Vincent and myself would be very proud to have stars named after us and hope you will name them this Friday. We have a baby sister named Anita, but as she only came from the stars three months ago, I guess she isn't very anxious to have a star named for her. Are you so busy

naming stars that you can't find time to shine any more? It seems like a long time since we saw you shining in the sky.

Theodore and Vincent Broun

> I am getting my sister to write and ask if you will name a star for me, as I am a little boy seven years old and have no mother or father and I am sure that if I hear my name over the wireless it will make me happy.
>
> Arthur Dull

What a story in this! It could serve as a fiction writer's inspiration—the little boy whose father and mother are dead and who would be happy if he had a star named after him—a star from up where *they* are! It almost brings a tear to one's eye to think of the tragedy in the home—and the little boy so anxiously waiting for his star.

Note and Personal: I can tell you, little girls, little boys, if you ever read this article, that the Man in the Moon is real. I have seen him. He lives and eats and has to go to bed just the same as anybody else does. He is a nice man and he wants to name a star after every good boy and girl. If it takes him a long time to get to you it will be because he has so many, many friends. Just keep right on believing in him—and some day there will be a star twinkling for you.

P. S. Don't worry. He says that he has lots and lots and lots of stars that have never been used.

Good night, I must stand by.

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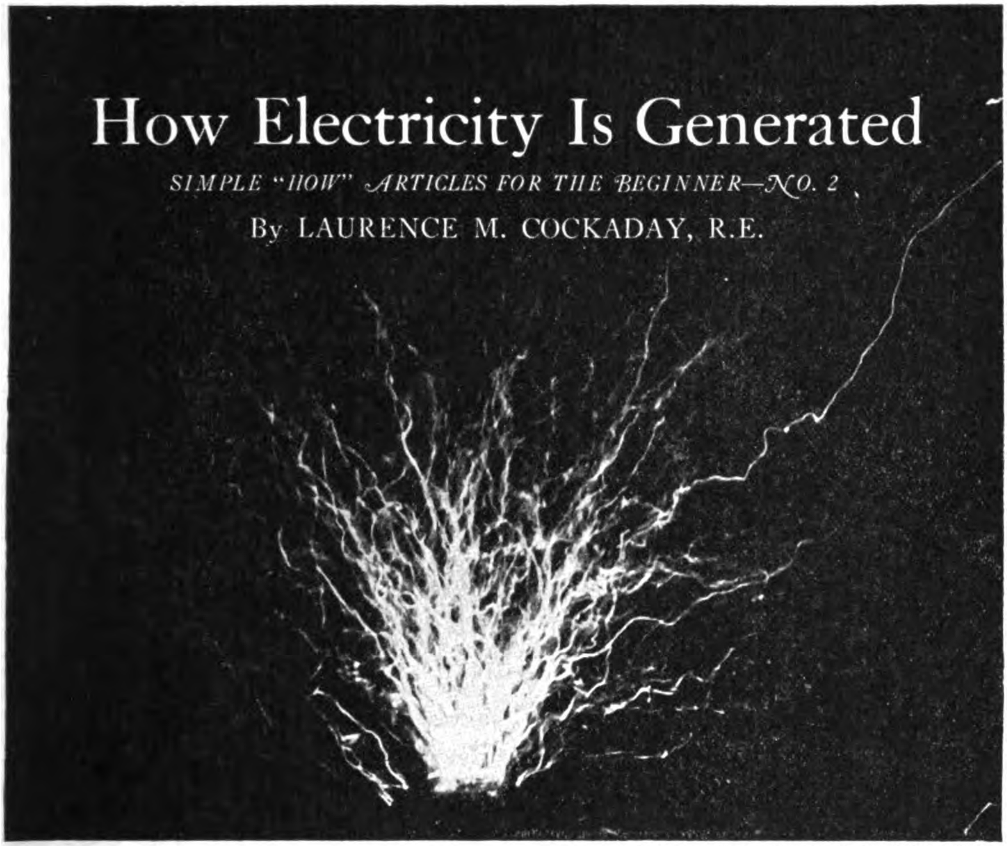
WHY LEAVE HOME TO GO TO COLLEGE?

The coming of the radio may have a far-reaching effect upon both our intermediate and our higher educational systems if the lecture courses that are being instituted by numerous schools and universities are carried to a logical conclusion. Thirteen members of the faculty of Tufts College have volunteered to broadcast lectures on their special subjects; this picture shows four of them—Prof. Arthur I. Andrews, Prof. Edward H. Rockwell, Dean Gardner C. Anthony and Prof. Albert H. Gilmer—in the station WGI, near Boston

How Electricity Is Generated

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 2

By LAURENCE M. COCKADAY, R.E.



From a photograph loaned by Nikola Tesla

TO understand the radio-telephone one must be familiar with the simple theory of electricity, and to understand the simple theory of electricity one must understand the electron theory, a theory of electricity and matter that explains every phenomenon of the scientific world known today, both in chemistry and electrical engineering.

The electron theory is now commonly accepted as fact by the world of science. It deals with the smallest division of matter, called the electron.

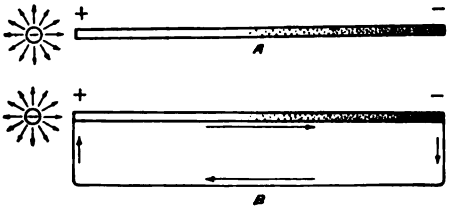
The electron is a minute charge of negative electricity; also is the smallest charge that it is possible for the human mind to conceive.

The atom is the smallest division of matter that exists in the form of matter; it is made up of a nucleus that consists of a positive charge of electricity surrounded by electrons. The only difference between the various kinds of atoms lies in the number of electrons which surround the positive charge or nucleus. Thus are explained many chemical changes that occur to substances; the number of electrons that surround the positive charge of a certain kind of atom may be deprived of a few electrons and the whole nature of the substance thereby changed. These electrons that surround the positive charge are held within certain limits as to the distance they may move from the positive charge by a very powerful though minute force.

To get a clear idea of the atom, compare it to the solar system. Liken the sun to the positive charge and the planets to the electrons. The electrons are held in their orbits around the nucleus in much the same manner as the planets revolve around the sun.

Next, consider two classes of materials that are of vital importance on account of their electrical properties; first, conductors of electricity and second, insulators against electricity.

Conductors of electricity (such, for example, as silver, copper, iron, and in fact



FIGURES 1A AND 1B

all metals to a certain extent), allow electricity to flow through their substance.

Insulators against electricity, (such as glass, rubber, wood, air, and numerous other materials) will not allow electricity to flow through their substance.

The conductive materials are made up of millions of atoms, which are in turn made up, as we have just learned, of a positive charge surrounded by minute charges of negative electricity called electrons. But the conductive materials contain, besides the atoms, countless numbers of free electrons which float in the spaces between the atoms.

Insulating materials contain few of these free electrons.

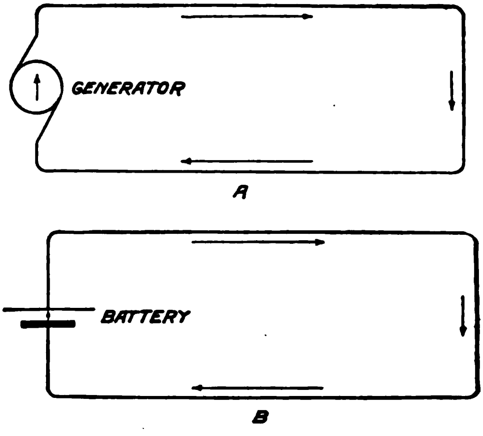
A positive charge and a negative charge brought into proximity to each other are attracted to each other. Two negative charges, on the other hand, repel each other when brought close together. So do two positive charges repel each other. This phenomenon may be easily remembered if put in the form of a scientific law:

If a unit charge of negative electricity is brought near enough to a positive charge, the attraction causes them both to run together and neutralize each other.

To understand how a current of electricity is created, first consider a copper rod as pictured in Figure 1A. This is composed of countless millions of atoms with millions of free electrons floating in between these atoms. If at one end of the rod is applied a strong negative charge or a number of charges, all of the free electrons in the rod, because they are negative charges, are repelled from the external negative charge and scramble about between the atoms in a mad rush to get to the furthest end of the rod from the external charge and all become crowded together at this far end. When a rod or wire is in this condition we say that the end where the negative charges are thickest is the *negative* end and the end where there is a scarcity of negative charges is called the *positive* end.

If there were a continuous circuit around from the negative end of the rod to the positive end the electrons would rush around through the circuit to the positive end, we would say that a current of electricity was flowing through the circuit. The current, however, is considered as running in the opposite direction to the flow of electrons, that is, in the opposite direction to the arrows showing the direction of the flow of electrons. See Figure 1B. If we were to try the same experiment with a glass rod we would not have any success, as there are few free electrons in an insulator and the electric current from these few stray free electrons would be so weak that we could not detect it except with an ultra-sensitive instrument. We say accordingly that no current of electricity flows through an insulator.

If, however, we should apply a strong external charge (which we might call a high voltage), the free electrons in the glass rod, even though they be few in



FIGURES 2A AND 2B

number, would be repelled so violently that they would collide with the atoms and knock off of them some of the electrons that were a basic part of these atoms. These freed electrons would then go racing along with the stream and soon the matter which composed the insulating rod would be decomposed and the electric current would flow through the rod in the form of a spark. In this condition the insulator is called "broken down" or ionized.

This same action takes place whenever a spark jumps across an air gap such as used in some types of wireless transmitting sets. When an atom of air has one or more electrons knocked off, its insulating properties are lost and it becomes ionized and is called an ion.

An electric generator is a device that causes electrons to be attracted to one of its terminals and repelled from the other terminal by magnetic action.

In other words, if a continuous conducting circuit is connected to the two terminals of a generator as shown in Figure 2A the generator keeps expelling electrons from one terminal and they flow around through the copper wire to the other terminal where they are sucked back in through the generator; the same process goes on continuously till the generator is shut down.

The electric battery does the same thing, only its action is chemical instead of magnetic. See Figure 2B.

Stationary charges of electricity, or "static electricity" as it is sometimes called, may be stored up in a device that is known as a condenser.

A condenser consists of two sheets of conducting metal that are separated by a sheet of insulating material such as glass or mica; in some cases air is used. This sheet of insulator is called the "dielectric," and the two conducting sheets are called "plates."

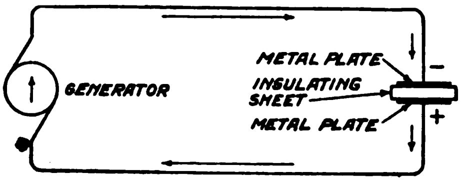


FIGURE 3

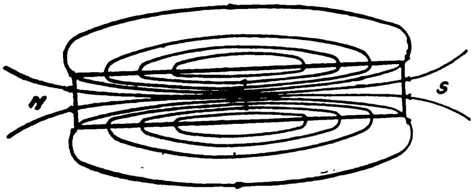
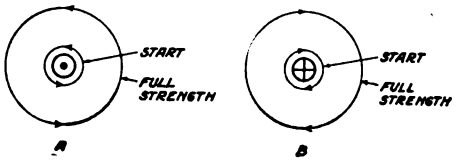


FIGURE 4

If we take such a device and connect it to a generator, the generator will suck all of the electrons from one of the plates and this plate will then become positive, and these electrons will be pumped by the generator on to the other plate, which will then have twice as many electrons as it should have normally, see Figure 3. The electrons cannot get back through the generator; neither can they pass through the dielectric or insulating sheet. If we suddenly disconnect the generator these electrons that are bunched on the negative plate will remain trapped there and we have a store of electrostatic energy in the condenser. When we want to make use of this energy we connect a wire around from the positive plate to the negative plate and the electrons will rush through the wire, thus causing a current to flow till the charge is spent and the electrons are back in their natural places. This action may be likened to the action of water running into a reservoir until the reservoir is filled; the water can be stored until it is needed; then the gates may be opened and the water will run out and be used for some useful purpose. So the condenser is used for charging up the high voltages that are used to produce the sparks that are seen jumping the air gap in the radio telegraph transmitter. Condensers are also used for tuning purposes.

When a current of electricity flows through a wire a magnetic field is set up around the wire. This field is the same as the field or magnetic disturbance that



FIGURES 5A AND 5B

is set up around the poles of a steel bar magnet, as shown in Figure 4. Imaginary lines of force called "magnetic flux lines" extend from the north pole of the magnet to the south pole and inside of the magnet from the south pole to the north pole. This magnetic energy is supposed to be revolving around following the paths of the imaginary lines as shown in the diagram. Looking at the end of a wire through which a current of electricity is flowing away from us, Figure 5A, a magnetic ring or number of rings start to revolve around the wire. The imaginary ring expands further and further as the current gets stronger; when the current gets up to full strength it stays out at a certain distance from the wire. When the current is turned off the magnetic ring quickly contracts until it collapses back upon the wire again. If the current should be reversed and flow toward us the ring would expand in just the same manner and collapse when the current is turned off, but the rings would revolve in the opposite direction. See Figure 5B.

As an analogy, we may liken these magnetic rings to rubber bands stretched around the wire that fit the wire tightly; when a current is passed through the wire the bands begin to revolve clockwise, slowly at first and then more rapidly as the current increases. As the centrifugal force increases from the rotation, the bands expand until the current reaches its full strength, the bands have attained their highest speed of rotation and the expansion process ceases and they stand out from the surface of the wire a definite distance, where they remain revolving at a definite rate of speed. When the current is turned off the speed of rotation decreases and the bands settle back until they come to rest on the surface of the wire. When the current is reversed the bands rotate in the opposite direction and the same process of expansion and contraction are experienced.

When two wires are placed side by side and close together and the current flows in the same direction in both wires, the rings enclose both of the wires instead of two separate sets of rings, and the speed of the rings is doubled.

This principle is made use of in the tuning coils of a radio set. Every turn added to the coil increases the magnetic effect as the wires of the coil are wound close together and the current flows in the same direction in the adjacent turns. This causes the magnetic lines of force to encircle the entire coil, extending from one end of the coil, outside the coil to the other end of the coil, and back through the inside of the coil. Compare the diagram in Figure 6 with the diagram of the magnet in Figure 4; the similarity of the two fields will be noticed.

A coil is sometimes referred to as an "electromagnet." One end of the coil will be the south pole and one will be the north pole with the current running through the winding in one direction; if the direction of the current should be reversed, the polarity of the coil would also be reversed. This idea of electromagnetic energy should be well fixed in the reader's mind before he proceeds further, as it is this principle that is used in all radio apparatus; it is indeed, the "open sesame" to the beginner who expects to understand more fully the intricacies of radio and the radio telephone.

These two forms of electric energy, electrostatic and electromagnetic, will be studied more fully in a subsequent article.

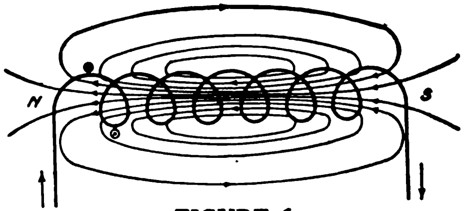
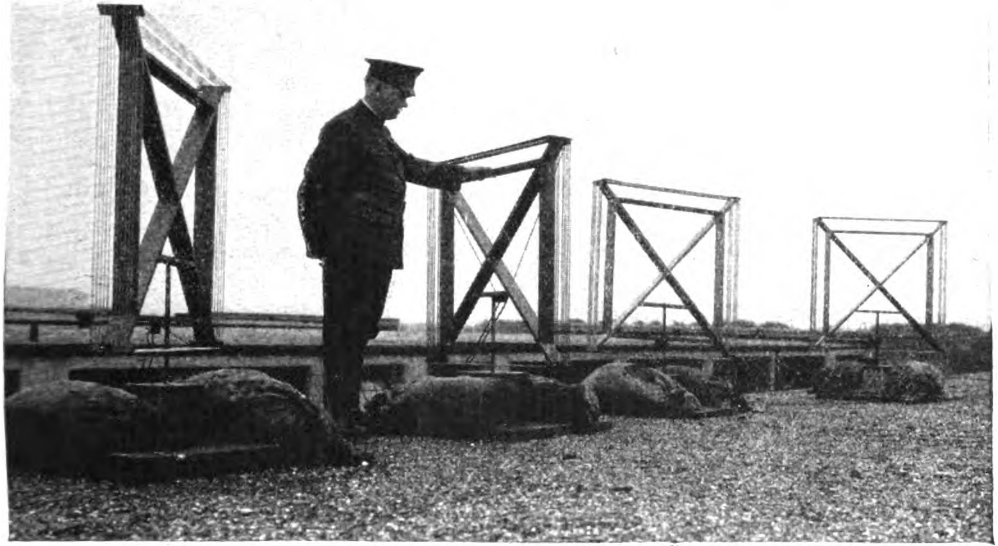


FIGURE 6



From a photograph made for POPULAR RADIO

THESE LOOP AERIALS ARE "SET" TOWARD DIFFERENT SENDING STATIONS

On the roof of the Munitions Building in Washington, D. C., where the army's radio central station is located, these antennae pick up messages that come about 6,000 miles.

"By Signal Corps Radio"

How the Newly Established Army Radio Central Is Saving Time and Money for Uncle Sam

By CAPT. WILLIAM E. MOORE

THE chief clerks of the War Department at Washington have been furnished with a new rubber stamp. It is marked *"By Signal Corps Radio."*

The use of this rubber stamp signals a new era in interdepartmental communication. For it means that the Army is handling communications within the continental confines of the United States through the Army Radio system. The Traffic Section has become, by general order, the message center of the Army. Every army communication that originates in the Washington military area will have to be sent to this message center for distribution; even those communications that are destined to be sent out over land wires must be sent to the message center. There the officer in charge will make the decision as to whether the message shall be sent out over the army radio net or by land wire.

The Signal Corps has worked with speed but without any blowing of trumpets at this job of installing a continent-wide radio system. During the war the army received some painful lessons as to the embarrassments involved in advertising what it intended to do ahead of time. There were in the army at that time some enthusiasts from civil life who believed that one way to win the war was to tell the public all about what they intended to do. In some well remembered instances the final accomplishment did not come up to the expectations. There was consequent disappointment to the public that was reflected in criticism of the army. That is the reason the army today does not believe in advertising what it is going to do.

The unostentatious manner in which the Signal Corps has carried out its plan of hooking up the entire army in America by radio was illustrated by an incident that recently took place in the office of Capt. R. B. Woolverton, the chief of the Radio Traffic Section. The Adjutant General's office called Capt. Woolverton on the telephone to inquire whether he could handle an army message by radio. The Adjutant-General was informed that messages could be sent into all but one of the corps areas in the United States. Communications with those two corps probably will have been perfected before this article appears in print.

The radio stations have not been completed in the 1st Corps area, comprising the New England States, nor in the 9th Corps area, comprising the Pacific Coast states. Through the co-operation of the Navy radio service, however, the army is enabled at the present time to communicate with 9th Corps Headquarters at Camp Lewis. The radio sections of the two branches of the military service work in the closest liaison. The army depends upon the Navy to carry its messages from the coast stations to all overseas posts of the army, such as Hawaii, Panama and the Philippines, while the army radio net is employed within the United States proper to carry Navy recruiting messages.

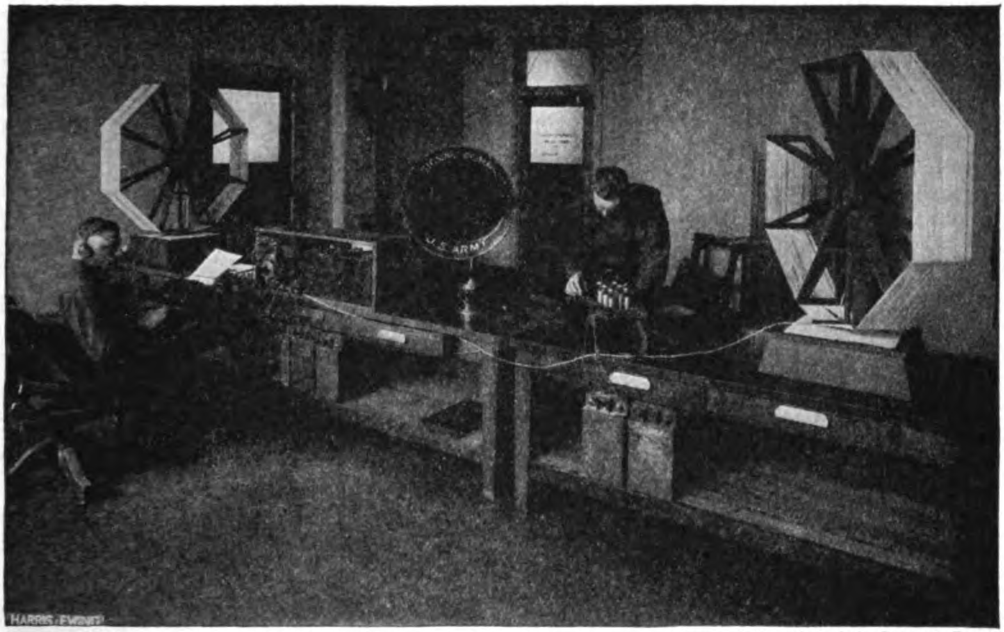
Pending the completion of the army's net work, the Navy is carrying army messages to the West coast in all emergency instances. The Navy flashes these rush messages from its station at Annapolis to the one at San Francisco. In return for this courtesy the army carries deferred messages for the Navy between the same points. Even after the army radio net is complete in all its details it is the intention of the government authorities to continue the plan of having transcontinental rush messages carried by the Navy, while to compensate the Navy for this work the army net will carry deferred Navy messages across the continent.

Through this interservice exchange there is assured a reciprocal and perfectly balanced system of communication between all parts of the United States and its overseas possessions.

Radio communication within the confines of the 8th Corps, stretching along the Mexican border, has been in operation since before the United States entered the World War, but the first station outside the border section was erected and opened for traffic December 10, 1921, at Ft. Benjamin Harrison at Indianapolis. Three months later, thirty-two stations were in operation in the United States and it was announced that within sixty days the number of stations will have been doubled. When that is accomplished it will be possible to communicate with any army post in the country by radio. Even the small one-company posts, if they are equipped with field radio sets, will be in touch through the ether, with all the other units of the army organization. The work of tying all the coast artillery posts into the army net is now under way and will have been completed before the first of June.

In Alaska the Signal Corps already has sixteen stations in operation. These are linked up with the army radio net in the United States proper by means of the army cable which runs under the ocean from Seattle to Alaska. That cable, by the way, is the only one that is owned by the United States government. When the work of the Signal Corps is completed the army post at Key West on the southernmost tip of Florida will be in direct and instant communication with the last out-lying post under the Arctic Circle in Alaska.

At present eleven of the thirty radio



From a photograph made for POPULAR RADIO

THE COMING TYPE OF LOOP AERIALS

Without the aid of towers or poles on the roof, these indoor antennae in the army radio central station receive signals from Rome, Italy.

stations in the army are equipped with radiophones; before many weeks have passed twelve more radiophones will be installed. This means that the principle army centers will not only be able to communicate by means of the written word but that they can communicate by word of mouth. What that means in terms of efficiency, especially at times of emergency, will be recognized by everyone whose business demands have taught him the relative value of telephone and telegraph.

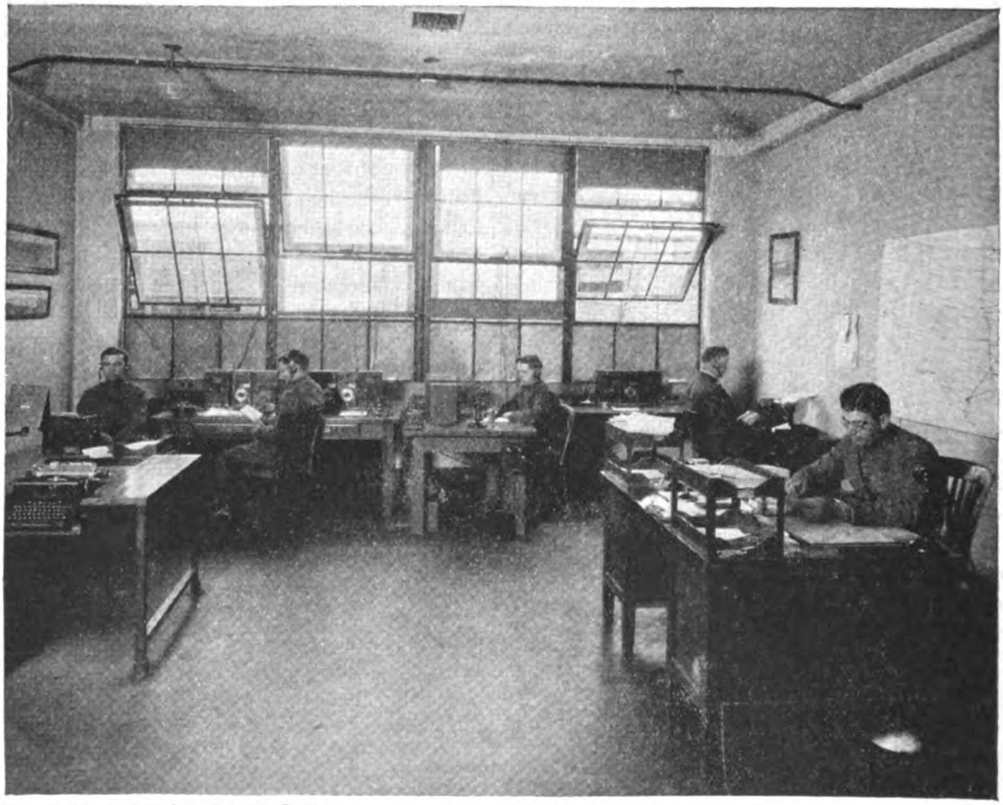
The efficient range of the army radiophones is 300 miles, while the range of the radiotelegraph is 1,000 miles. Relay stations will be utilized for longer distances. The distance between Washington and San Francisco is approximately 3,000 miles. An army radiotelegram started from the national capital to the coast town is relayed from stations at Omaha and Salt Lake City.

The chief significance of the installation of the Signal Corps' radio net is that hereafter the nation will be entirely independent of commercial lines of communication, no matter what emergencies arise. If storms or blizzards should destroy every pole and line in the United States the radio sets of the army could still carry on the essential business of the government and, in addition, could largely aid private agencies in keeping up the necessary business of the day. When the army net is completed, as it soon will be, the peace-time establishment of the army within the continental limits of the United States will be established upon as firm a footing as regards instant touch with all its elements as was the war-time army in France, where the front line trenches were tied in, by means of the army radio net, with General Pershing's personal headquarters at Chaumont.

Civilians will scarcely understand the guaranty of national safety that is embodied in the above statement, but to all those who served in the army abroad it will carry an assurance of preparedness for any emergency. In its study of the many questions of national defense the army has had to consider the possibility of domestic upheaval resulting from strikes, "red" demonstrations or other causes. Quick mobilization is, of course, of the highest importance under such circumstances. Under the terms of the new army organization, both the National Guard and the Reserves form part of the Army of the United States. All the units of those elements of the army are held in the closest touch these days with the headquarters of the corps in which they are grouped. A word flashed by radio from Washington would call to immediate service every regular and citizen soldier in any section of the country where danger threatened. And no destruction of telegraph and telephone lines would prevent the summons to arms from reaching its destination.

When President Taft was inaugurated in 1908 a severe blizzard in Washington and along the East Atlantic coast isolated the national capital for twenty-four hours. Such a condition will never again be possible now that the Signal Corps' radio service links every part of America with every other.

In ordinary times the army net will be employed only in carrying purely military business, unless other arms of the government come to employ it for broadcasting purposes. The sending out of daily information bulletins has recently come to be an important feature of departmental business; with the increasing facility for spreading this sort



From a photograph made by POPULAR RADIO

THE HEART OF THE ARMY "MESSAGE CENTER"

The office of Capt. R. B. Woolverton, of the Signal Corps, in Washington, through which all army radio messages may be transmitted to and received from every one of the nine corps areas—at a substantial saving in telegraph bills.

of news among the people it is certain that the volume will constantly increase. There has been discussion in government circles in Washington as to whether the army radio system should be employed for broadcasting farm service information for the Department of Agriculture. With its present number of twenty-three broadcasting stations the army is equipped to carry out that work today and is only awaiting an order from the proper source to undertake it. A decision in this matter is said to depend upon whether the Post Office Department will also enter the wireless field and assume the function of broadcasting information issuing from the civilian branches of the public service.

It is none of the army's business what other rivals enter the national service in the radio field. A decision there must rest with Congress and the taxpayers who vote for the Congressmen. But if Uncle Sam in his wisdom should call upon the army to take up the duties of news carrier to the farmers the army is equipped and ready for the job.

Mention of the taxpayer brings up the question of the cost involved in linking up all parts of the nation by means of the army radio system. Up to date, with half of the work completed, the cost has been only $500,000. The total probably will be in the neighborhood of $1,000,000.

But the saving to the army in commercial telegraph tolls will make up the cost of installation within a short space of time. The army does a great deal of telegraphing, and some telephoning. Hitherto most of this has been turned over to private organizations for transmission. Hereafter the work will be done by the army itself, with soldier operators sending over army radio sets. That the saving thus accomplished will result in higher efficiency cannot be questioned. Economy is the password of the day in government circles these days. Military and civilian servants of the nation hesitate long before they spend a cent of Uncle Sam's money. They are all afraid Gen. Dawes will get 'em, if they don't watch out.

When the army dirigible *Roma* burned at Langley Field, Va., with a fearful loss of life, there was a rush of Washington correspondents to the offices of the army Air Service to obtain details of the catastrophe. There the writers ran into the hard and fast rules for economy that have been established throughout every branch of the government service. The long distance telephone in the office of the officer in charge could not be used because the army had no authorization to spend money to obtain news for the press. After some argument an idea presented itself to one of the correspondents. The newspaper men raised the required amount $7.50, among themselves and paid for the call. Then the officer did the talking and obtained the official information they all were seeking.

In this instance the alert Washington correspondents had overlooked the one method of instantaneous communication with Langley Field. The installation of the army radio net has been carried on so quietly that even these usually well informed journalists do not yet know about it. News of the *Roma* disaster was instantly flashed to the Radio Section in Washington that day, and both the Chief of Staff, Gen. Pershing, and the Chief Signal Officer of the Army availed themselves of the radio service to keep themselves informed regarding the progress of the rescue work at Langley Field.

All of the fifteen Air Service fields have already been tied into the army net by radio. The Signal Corps supplies each flying field in the army with an airplane radio set, including radiophones for use between planes in the air and between the planes and the ground stations. The radio telegraph radius of the instruments is 300 miles.

All Air Service fields are being equipped with radio sets exactly similar to the army radio net equipments for the purpose of enabling stations to transmit meteorological data from one station to another and throughout the army. This furnishes insurance against disasters of the air resulting from unexpected storms. In the past numbers of planes had met with accidents and sometimes destruction through unlooked for weather conditions while on long flights. Under the new conditions whereby each plane is in constant touch with all stations, such accidents can be easily avoided. If the newly installed system had been in operation last fall when the giant army flying machine *Eagle* was destroyed, with loss of life, while on a flight between Washington and Langley Field, that catastrophe would have been averted.

The flying field installation is known in the army as the "Alert Net;" it will be available not only for the flyers of the army, but for aerial mail carriers of the Post Office service as well. The army's transcontinental stations at Omaha, Cheyenne and Salt Lake City are all on the route of the transcontinental air mail service, and so can guard the postal route without any duplication of equipment or expense.

What other national duties and responsibilities the Signal Corps radio service will be able to assume have not yet been ascertained. The possibilities are so vast that even the experts who installed the system refuse to hazard a guess as to what another year will bring forth in the way of communicating through the ether.

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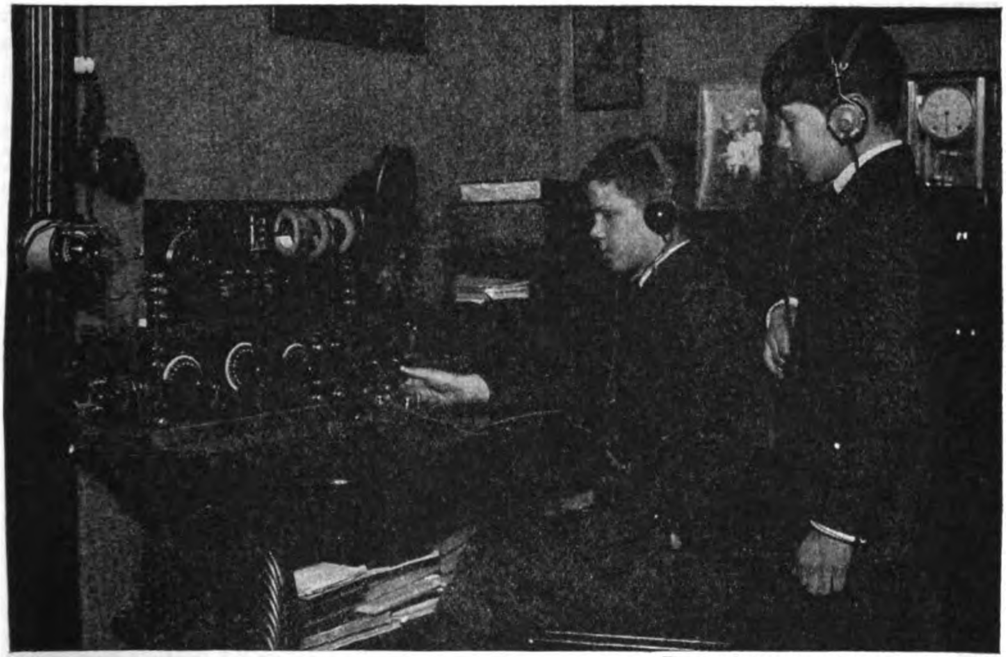
THE FIRST SINGER TO GIVE A RADIO CONCERT FROM THE SKY

A unique recital that established a precedent was given in April by Miss Jeannette Vreeland, an opera singer, who broadcasted a program from a Fokker airplane that was speeding through the clouds over Hazelhurst Field, near New York. The concert was transmitted by a 50-watt set on a 507-meter wavelength with a range of 500 miles. On Miss Vreeland's right is Lieut. Belvin W. Maynard, the famous "Flying Parson."



From a photograph made for Popular Radio

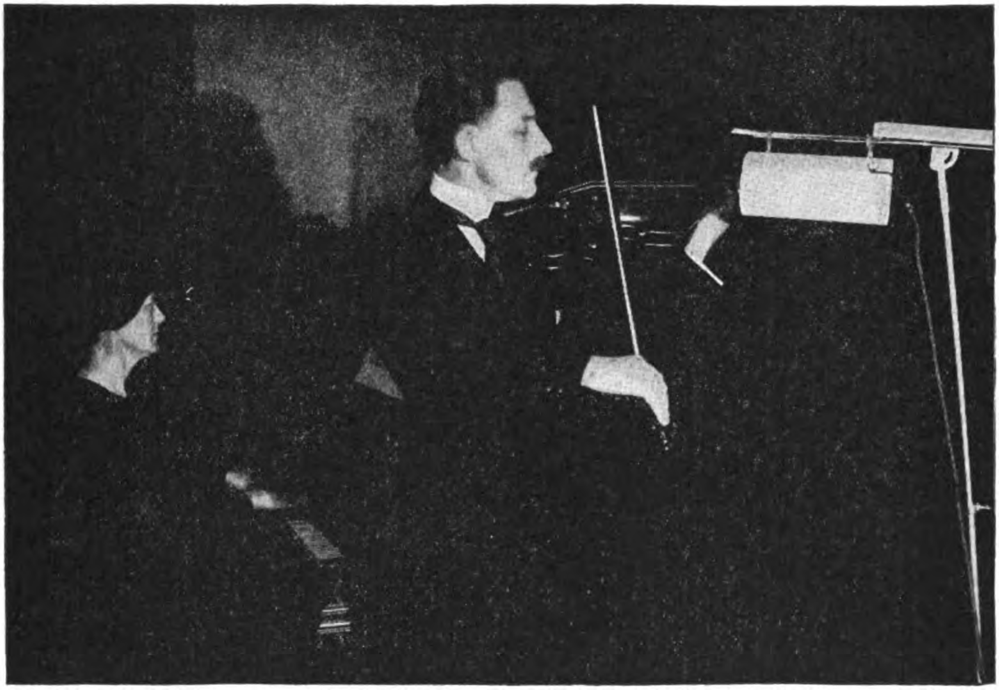
A $200 Set Built *for* a Business Man

AN exceptionally serviceable long-distance receiving set that was assembled by a New York business man is illustrated in the picture at the top of this page. The owner—Mr. Julian Chase—had no technical experience in radio work; indeed, one of the remarkable features of the set is the fact that the owner obtained his ideas partly from his radio amateur friends and partly from newspaper and magazine articles, and only incidentally from his casual operation of a small receiving set which he formerly owned.

The set is unusual, too, in that it is complete in detail for receiving all wavelengths that are used both commercially and by the amateurs, as it has a range of from 200 to 20,000 meters.

In the lower left hand corner may be seen the low wave set that is used for listening to the nightly concerts and to amateurs. To the right of this cabinet is the two-stage amplifier which amplifies the signals to great strength. Directly above the low wave set is seen the high wave set for listening to the long-distance commercial stations of this and foreign countries. The two middle switches of the upper set are used for changing over from the low wave set to the high wave set; above these switches are mounted the honeycomb coils that enable these high wavelength stations to be received. The two dials at each end of the set are attached to the tuning condensers.

Mr. Chase uses a horizontal V antenna for receiving with the lead in at the point of the V. The average length of the antenna is 90 feet. The low wave set has enabled the owner and his family and friends to hear the concerts from Newark, N. J., Pittsburgh, Pa., Detroit, Mich., Schenectady, N. Y., and occasionally from Chicago, Ill. With the high wave set, messages from Nauen, Germany, Rome, Italy, Elvise, Germany and numerous other foreign stations have been heard with sufficient strength to operate the loud speaker that is mounted on the wall at the right of the high wave set.



Westinghouse. Photo of Scipio Sindl.

THE STAR PERFORMER AMONG THE INSTRUMENTS

The violin tones are sent out by radio with almost entire fidelity, followed closely by the other stringed instruments and by the woodwinds.

Tones *that* Do *and* Don't Broadcast

The Unexpected Problems in the Transmission of Music by Radio that the New Type of Impresario Has Had to Solve

By WILLIAM H. EASTON, Ph. D.

ONE-two-three-four — hello-hello-hello—one-two-three-four —— " Have you ever picked up this string of nonsense in your receiver? If so, you have stumbled upon a radio engineer at work on improving his transmitting apparatus. Why he should use this particular formula is not clear, but it has become a tradition in radio circles, just as "This is the time for all good men to come to the aid of the party" has among stenographers.

An immense amount of the most careful kind of engineering work was necessary to produce the present radio concert. Only a short time ago a listener was astonished if he could hear anything at all and satisfied if he could distinguish "Home. Sweet Home" from the "Wabash Blues." But now he is satisfied with nothing short of a finished artistic performance, so that even after the radio engineer has succeeded in transmitting intelligible messages, he was given no rest; he has had to refine every detail of the radio telephone until a perfect reproduction of the original sounds became possible.

One of the most amazing of the early troubles was "blasting." This is due to the excessive vibration of some part of the microphone, and it produces most unpleasant sounds when certain notes are struck. Endless experiments were carried on to eliminate it. Microphones were made of wood, tin, lead, parchment and fiber. They were made big and little, conical, cylindrical and flat. Gradually the trouble was eliminated and it is now no longer heard in the performances of the better broadcasting stations. Members of the radio audience of at least six months' standing will appreciate the improvement that has been made in this respect. Last fall it was considered impractical to broadcast a quartette because of the blasting caused by the combined voices, but now full orchestras, bands, and choruses can be handled without difficulty.

But the big struggle was with the piano. This instrument is absolutely indispensable but it is the most difficult of all to reproduce and transmit. The first attempts were dismal failures. The bass notes were a complete jumble; the middle register was tinny and the top notes refused to come through at all. Each element was given the most careful study, however, and microphones were literally built up around the piano's peculiarities. Recent results are highly satisfactory, and though there is admittedly still room for further improvement, a radio piano recital will now please even the most critical musicians.

With the piano conquered, none of the instruments present any special difficulties. The stringed instruments, such as the violin, harp, banjo and ukelele, are transmitted with entire fidelity, as are also the woodwind group, such as the clarinet and flute, and the instruments of percussion, such as the bells and the xylophone. Brass instruments, being for the most part inherently blatant, require careful handling, and cornets if blown directly into the microphone may still cause blasting.

But of all the musical instruments, the human voice is best adapted to radio broadcasting; and of all voices, the soprano is the most effective. The notes of the *artiste* are transmitted without perceptible loss and can be heard at far greater distances than any other sounds. Many listeners along the Atlantic Coast could plainly hear Mary Garden or Edith Mason when the Chicago Opera was being broadcasted from KYW, but they were entirely unable to catch the faintest trace of orchestra, chorus, or any other singer.

Of the other voices, the contralto is favored least by radio, as her deep, 'cello tones sometimes lose some of their velvety richness in transmission. Yet much depends upon the individual singer. The writer interrupted this very article to listen to a contralto whose voice seemed perfection in the ear-phones.

But a perfect instrument does not mean a successful concert. The best of pianos will do little for a poor performer, and the most complete of broadcasting stations will not give a performance that will please the audience unless it is in the hands of an experienced management.

Westinghouse photo of Gustave Longernus

THE CLARINET IS TROUBLESOME

While the mechanical clicking of the stops is unnoticed by the human ear, the radiophone not merely records it but exaggerates the sound.

One of the problems to which the manager gives special attention is the selection of artists. It not infrequently happens that a singer who enjoys an enviable reputation fails to produce a good impression by radio. Sometimes this is because the singer's success is due to personality rather than to voice, and sometimes because the radio telephone is unable to transmit the voice properly, although there is less and less trouble from this source as the transmitting apparatus is improved. The manager soon gets to know which vocal qualities are desirable and which are undesirable, but he never can be entirely certain of a singer's fitness for radio work until after an actual trial.

One condition makes his work different from that of an ordinary concert manager. In the concert hall or theatre, the musician is rarely less than fifteen or twenty feet from the nearest of the audience, but in the broadcasting studio, the microphone, which represents the listener's ears, is within two or three feet. Hence many tricks of articulation or breathing that pass unnoticed on the stage are plainly audible to the radio audience. For the same reason the clarinet and some other instruments must be placed at some distance from the microphone, or else the clicking of the stops will mar the performance. The flute, however, having no mechanical stops, does not require this precaution.

The placing of the soloist and the accompanist, and grouping of voices in a chorus or instruments in a band, and the selection of the proper microphone for each combination, are also matters that must be decided by the manager. In some of the larger broadcasting studios, a plan of the floor is made, and the locations of microphones and artists for all of the more usual performances are indicated on it. But new situations frequently come up and raise questions that can only be answered by a trial. Listeners can often note a decided improvement in a second selection over the first one in a given concert because some needed change was made during the intermission.

To help him, the manager has a staff of critics, who listen in at their homes

Westinghouse photo of Caroline Beebe

PIANO MUSIC WAS THE MOST DIFFICULT OF ALL TO BROADCAST

This indispensable instrument presented the greatest mechanical obstacles to transmission of its sounds by radio, and for a long time efforts to overcome them were dire failures.

and phone him if improvements are necessary. Some of them are employees of the company that operates the station; but the majority are unofficial members of the audience who are well versed in radio and music.

"Bring the tenor of that quartette forward! He isn't coming over strong enough."

"The trombones of that band are too loud. Keep them down."

"Tell that soprano to use less effort in her upper register."

"Tone down the piano! It's drowning the soloist."

Such are some of the messages these critics send in. The manager, of course, listens in constantly at a local receiver and is aware of most of the defects before anyone else can tell him of them, but he is so near the source of the sounds that certain imperfections escape him, and therefore he needs aid from those located at a distance.

Another one of the problems of the management is to produce a program of the most varied nature. Nothing suits everyone. Some people detest classical selections; others will not stand for jazz; and still others dislike music of any kind. The endeavor is therefore to suit all reputable tastes by compiling the list of artists and speakers on the theory that those who do not wish to listen to one will find the next one entirely to their liking. The standard applied to each number is, "Will this be of interest to at least 50 per cent. of the audience?" All matters with merely a local or group appeal are, therefore, ruled out.

Of course a station is criticised for many things that are the fault of neither its apparatus nor its management. Good reception depends just as much upon the receiver as the transmitter, and a rundown battery or a defective tube in the receiving apparatus will spoil any program, no matter how well it is transmitted. Interference from other stations also causes trouble. In addition, artists are human and are liable to fall ill suddenly or be unavoidably prevented from fulfilling an engagement for some other reason. Even the Metropolitan Opera Company is occasionally compelled to change its offering. The record of two of the major broadcasting stations is, however, that no artist of repute has ever broken an engagement except for absolutely compulsory reasons, and when disappointments have occurred an appearance has been made at the earliest opportunity.

Westinghouse photo Os-ke-mon-ton

THE EASIEST AND THE HARDEST SOUNDS TO TRANSMIT

The human voice is better adapted to radio broadcasting than any other sound—and the brass horn is the worst.

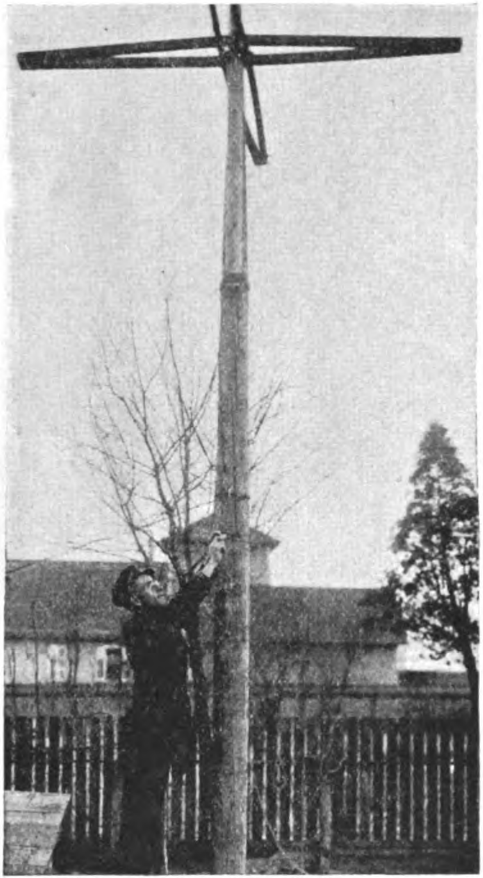
It is trite to say radio broadcasting is in its infancy. But it is in fact only eighteen months old; and if it continues to improve technically and artistically at its present rate, its possibilities will surpass anything that the most vivid imagination can dream of today.

¶ *Is the Radio Helping or Hurting the Church?*
Read the Next Number of POPULAR RADIO — *for July*

An Amateur Who Made a World's Record

How a Sailor Accomplished the Surprising Feat of Sending a Radio Message Across the Atlantic on a "Little 20 Watt Outfit"

By RICHARD LORD



From a photograph made for Popular Radio

SAILOR COLLINS FASTENS THE COUNTERPOISE WIRES

The counterpoise antenna is stretched between the two towers that support the main antenna and is strung eight feet above the ground.

WHEN a gob makes up his mind to do something he usually does it, or has a good reason for failing. Here is the real story of a real gob who accomplished one of the most remarkable feats ever attempted by a radio amateur, and did it too against overwhelming odds.

The gob's name is Harry S. Collins, and he lives in Bayport, Long Island. He walked into one of the largest radio stores in New York one day last December and asked the manager whether he thought that his station, 2AJW, could possibly be heard by Godley in England.

"Some of us big fellows will probably be heard over there, but I don't think there is a chance for that little 20 watt outfit of yours," the manager told him.

That is a good way to get a determined radio amateur started.

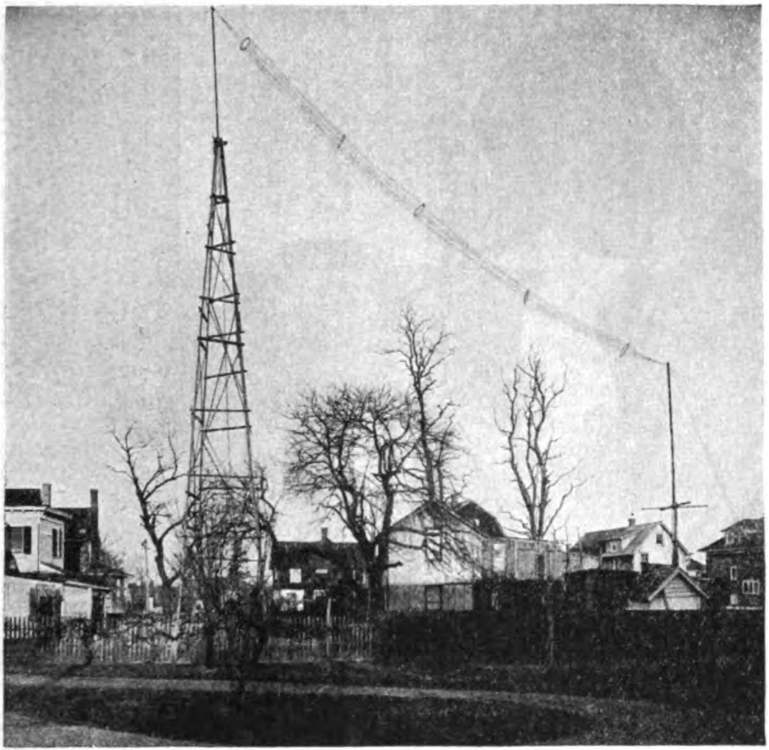
A little more than a week remained before the America-Scotland radio tests. Collins got busy. He built a sectional mast especially for these tests. It is a good model for the amateurs in the country to copy. The mast was built in three sections, each 20 feet long and 2 inches thick by 4 inches wide. The three sections were crowned by a 21-foot 1-inch iron pipe set in a special socket. The total height was 71 feet.

The method of construction which Mr. Collins used is novel; instead of building from the ground up he put his three sections together with the mast lying on its side. Then when it was completely assembled it was hoisted up by means of a block and tackle. The final step consisted of placing the iron pipe in its socket.

The antenna itself is a six-wire cage coming down to the lead-in insulator in the form of a diminutive cage.

But even with the aid of this antenna the attempt to be heard in Europe on 20 watts input seemed to most of Collins' friends as impossible as trying to tame a jungle tiger with a pitcher of milk.

To make results a bit more certain, Collins added two extra 5-watt tubes to



From a photograph made for Popular Radio

THE SECRET OF THIS STATION'S RECORD IS CREDITED TO THIS ANTENNA SYSTEM

This is the aerial that enabled an amateur to send a radio message across the ocean with a low power vacuum tube transmitter. The lattice tower is the main support of the cage type of antenna.

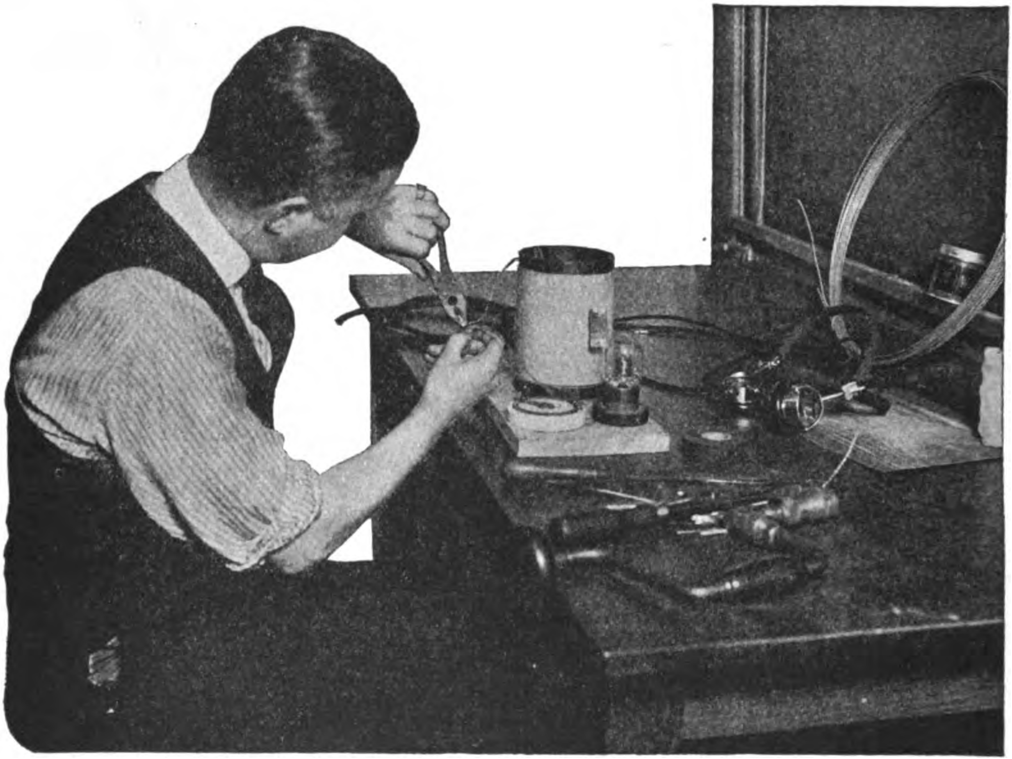
his equipment, thus raising his antenna radiation to approximately 20 watts. The circuit used was the conventional Colpitts, and the plate potential supply obtained from a 575-volt generator.

While Godley was freezing in the leaky tent at Androssan, Scotland, Collins pounded the key night after night with indomitable patience. If I did not know Collins, I would not believe that he had the faith that he was actually getting across. His faith must in itself have added about 100 watts to his output; otherwise I cannot explain how he did it. Certainly it wasn't luck because luck implies chance. Collins deliberately set out to establish this record and he did it. I hope his apparatus will some day be placed on exhibition in the Smithsonian Institute. Even our grandchildren, with their vest pocket radio telephones, will marvel.

Additional evidence that Collins' feat was not merely a matter of chance is the remarkable work which his station, 2AJW, is doing night after night. Using but four 5-watt tubes he has been reported in twenty states and in Canada. He has been heard in every seaport state from Maine to Florida, except Delaware and South Carolina. His radio telephone, using grid modulation, has been heard at IZE, Boston, Mass., and as far south as 3BA, Cape May, N. J.

Expensive radio equipment is not the only element that makes possible the remarkable feats that amateurs so often accomplish. Other factors are skill and persistence.

Collins has them.



From a photograph made for Popular Radio

YOU CAN SAVE FROM $6.00 to $35.00 IF YOU MAKE IT YOURSELF

Contrary to the usual belief a tube set is just as easy to make as a crystal set, and a home-made set has many advantages over a ready-made outfit.

How *to* Make a Simple Tube Receiving Set

A Complete and Detailed List of Instructions for the Radio Amateur, Illustrated with Sketches by the Author—

A. HYATT VERRILL

MANY people think that a crystal set is much simpler than a vacuum tube receiving set and that to make the latter requires a great deal of skill and knowledge. As a matter of fact it is just as easy to make your own tube set as the crystal detector set.

Of course, a tube set will cost considerably more, as the batteries and tube add to the expense; furthermore some of the instruments used cannot well be made at home. But even despite all that, many dollars may be saved by making your own set, and in addition you will have the pleasure and satisfaction to be derived from hearing the music, songs and other messages coming in to your ears over a set you have made yourself.

To make such a set as is illustrated in Figure 1, will cost from $29.00 to $40.00 complete, if all the parts are purchased ready-made; the price naturally depends upon the quality of the supplies and instruments you use. The prices are:

Aerial and ground wires	$0.75	to	1.50
Miscellaneous wires and fittings	.75	"	1.25
Insulators	1.00	"	1.25
Air-gap or lightning switch	.50	"	.50
Vacuum tube	5.00	"	6.00
Vacuum tube socket	.60	"	1.50
Rheostat	.50	"	1.50
Variable condenser	3.50	"	5.00
Phone receivers	4.00	"	5.00
Grid-leak and condenser	.40	"	.50
22 volt "B" battery	2.00	"	4.00
6 volt "A" battery	10.00	"	12.00
Total cost	$29.00	to	$40.00

Such a set, if well made, will compare with a set which will cost ready-made from $35.00 to $75.00 if bought complete; as such sets are usually priced without batteries, phones or tube, the saving will be enough to enable you to build another set or an amplifier.

A home-made set has one great advantage over many of the ready-made sets, inasmuch as there are but three adjustments to be made in using it; the rheostat, the coil, and the variable condenser—instead of four or five adjustments as on many other sets. Although both the variable and fixed condensers may be home-made, yet it is not advisable to attempt the former as it is by no means a simple or easy matter to produce an efficient instrument of a definite capacity, which, in this case, should be about .001 mfd. The fixed condenser and grid-leak, on the other hand, are simple affairs and are easily constructed. However, as they can be purchased complete for a few cents it is scarcely worth while to attempt to make them unless you are anxious to make as much of the set as possible for the practice and pleasure you get out of the task.

The condenser consists of three strips of waxed paper (which may be purchased or may be made by soaking heavy note paper in melted paraffine wax) and two pieces of tin foil. The paper strips should be cut to about two and one-half inches in length and two inches in width; to make it easier to centre the foil it is a good plan to draw a smaller rectangle, one inch by one-half inch, on each piece of paper—using a hard pencil and very light lines—thus leaving a border ¾ of an inch all around, as shown in Figure 2.

Cut two pieces of flexible, well insulated copper wire about six inches long, and from one end of each, remove the insulation and fray out and flatten the strands of wire. Place one of these frayed ends upon the strip of paper with the flattened strands within the pencil line (Figure 2). Cut a sheet of tin foil, which must be free from holes and tears, one inch in length and half an inch wide and place this smoothly over the wire on the paper, using the pencil marks as a guide to centre it, as shown in Figure 3. Secure the wire and foil in place by a few drops of melted paraffine on the projecting border of the paper and place the second strip of paper over the foil. Lay the other sheet of foil on this and place the frayed-out strands of the second wire upon it, *but at the opposite end from the first wire.* Secure it in position with paraffine and place the third sheet of paper over all, as shown in Figure 4. With drops of melted paraffine, fasten the edges of the paper and the wires together. Then carefully roll the whole into a neat cylinder and wrap the ends securely with strong thread as in Figure 5. Finish by dipping the whole quickly into melted paraffine, by winding it smoothly with "Tirro" tape or by slipping it into a section of "varnished cambric tubing" which may be bought from any dealer in electrical or radio supplies.

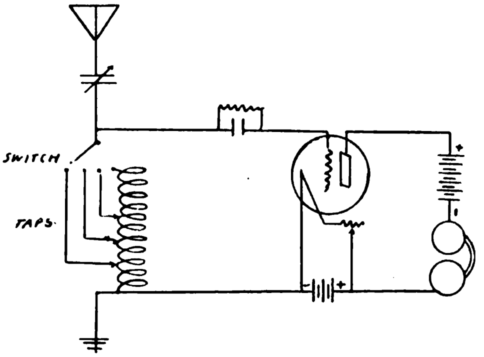


FIGURE 1

The grid-leak is merely a piece of heavy note paper, or thin bristol board, placed between the two binding posts that are connected with the condenser, with pencil lines drawn on the card from post to post. Make the lines with a soft pencil; to insure a good contact carry them around the holes made in the card to receive the posts, as illustrated in Figure 6, and connect them as in Figure 7, so that the space between the binding posts does not exceed five-eighths of an inch.

Another type of condenser which is even neater and more compact and is just as simple to make employs two copper sheets and binding posts in place of foil and wire. To make this you should have some very thin sheet copper, some thin cardboard or bristol board, some waxed paper and two 3/16-inch binding posts (those from an old dry battery carbon will do very well). Cut two pieces of cardboard and one of waxed paper each two and one-half inches long and one and one-half inches wide. Cut the copper strips to 1½ inches in length and ½ inch in width. Next, mark on the card and paper the places for making the holes for the binding screws. These should be ¼ inch from each end of the strips; by making the holes in one strip and then placing this over the next, marking about the holes and so on, all may be made exactly alike. Next, place the copper strips so that one end is ¼ inch from one end of the paper or card and mark for a hole in one end (Figure 8) of each piece. In making the holes in the copper, see that they are small enough so that you have to force the binding screw through them.

Finally, you will require two short pieces of copper, each ¾ inch long by about ¼ inch wide with a hole ¼ inch from one end of each, to take the binding posts.

The condenser is now ready to assemble, but if you wish a grid-leak to use with it first mark lines with a soft pencil from one hole to the other on one of the strips of cardboard. To assemble them place the two posts through one of the

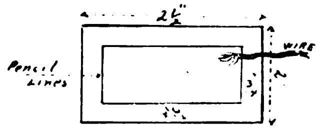
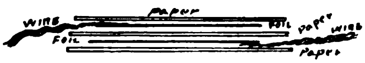


FIGURE 2

FIGURE 3



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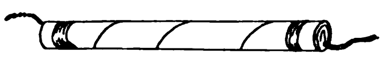
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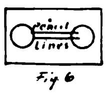


FIGURE 6

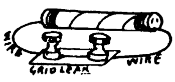


FIGURE 7

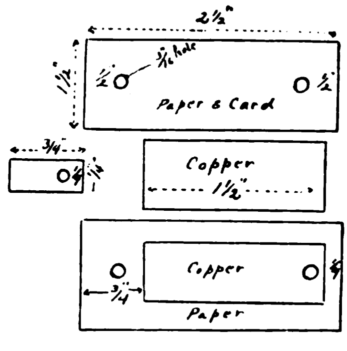


FIGURE 8

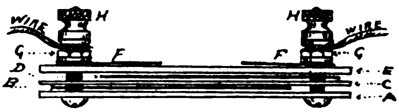


FIGURE 9

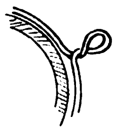


FIGURE 10

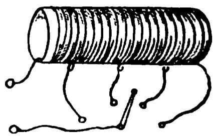


FIGURE 11

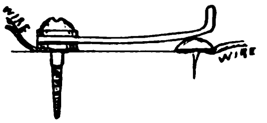


FIGURE 12

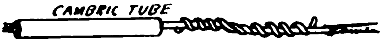


FIGURE 13

cardboard strips, with the card resting on the heads of the screws, as shown in Figure 9 (A). Place one of the copper sheets on this, slipping the hole over one post (B). Place a sheet of waxed paper over this (C). Place the other strip of copper on this and over the screw at the *opposite end from the first,* (D), and over this place the second sheet of cardboard with the pencil mark up (E). Then, place one of the small pieces of copper over each binding post (F), place washers on the screws and screw down the nuts as shown in Figure 9 (G). To connect with the set, wrap the ends of the wires about the projecting screws, place a washer over them and screw on another nut or a thumb nut, Figure 9 (H).

To make the coil for this set is as simple as to make the condenser. It is merely a "Formica" tube about three and one-half inches in diameter wound with about 45 turns of No. 26 double cotton covered copper wire and with three "taps" taken from it.

To make the coil, start the wire through a hole about one inch from one end of the tube and proceed to wind on ten turns. Then make a loop in the wire, by taking two twists on itself (Figure 10) and continue winding as before, keeping the turns or coils about ¼ inch apart. When you have wound on ten more turns make a second loop or tap and at the thirtieth turn make a third and finish winding and run the end of the wire through another hole about one inch from the end, as at starting. Leave several inches of wire free at both ends of the coil and fasten the wire to the inner side of the tube by means of sealing wax. Scrape each of the tap loops free from insulation and attach short lengths of insulated wire to each. Make a good connection, soldering if possible, and finish by covering with varnished cambric tubing. Mount the coil by driving brass tacks or screws from the inside of the tube through the bare spaces at the ends into a suitable panel or base. Then, lead one of the end wires and the wire from each tap to the four contact points of a switch, as shown in Figure 11, and connect the switch-arm to a short wire leading to a binding post and the other wire from the coil end to another binding post as shown.

When you connect up the coil in the set, the lead-in wire is attached to the binding post connecting with the switch-arm and the ground wire is led to the other post, as indicated in Figure 11. If you do not care to buy a switch you can make one very easily by using brass-headed upholsterers' tacks driven through loops in the wires—(but be sure that the insulation is first removed and the wires are clean and bright)—or by using round-headed, brass wood screws for contact points. The switch arm may be made of a strip of spring brass attached to the panel by means of a round-headed brass screw with washers above and below the arm, as shown in Figure 12.

In wiring up this set, or any other set, be careful to make good connections with the wires. The best way to do this is to twist one wire around the other, as

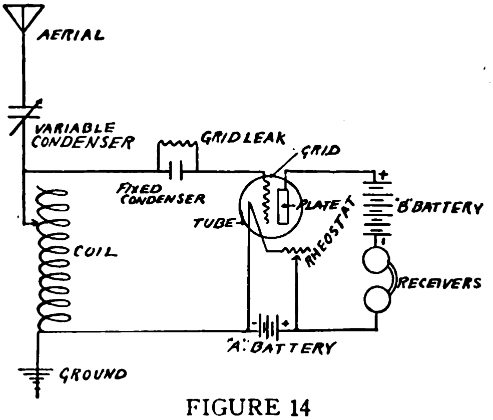


FIGURE 14

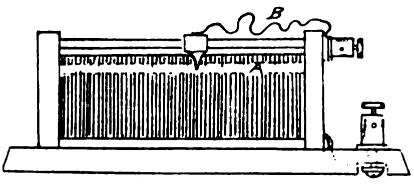


FIGURE 15

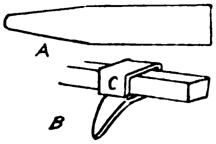


FIGURE 16

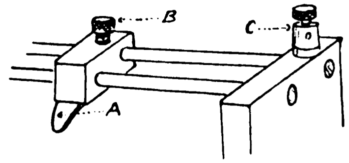


FIGURE 17

shown in Figure 13. Then the two may be soldered together, and the joint covered by slipping a section of varnished cambric tubing, which comes in various sizes, over the joint.

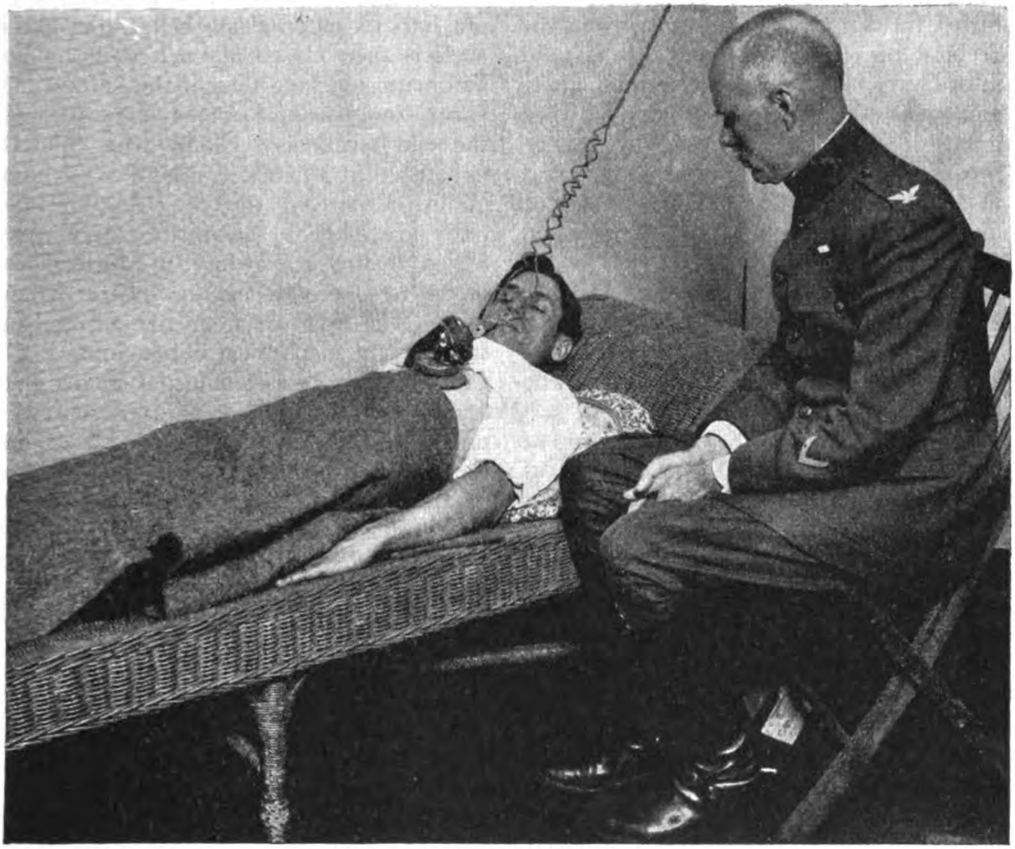
Also, be sure and do *not* run the wires parallel. Although they are thus shown in the diagram it is merely to make the figures look better and for convenience in drawing.

An even better set may be made by following the plan shown in Figure 14, in which a slider or variable coil (Figure 15) is used in place of the plain coil already described. This will add nothing to the expense of the set and will give far better results in tuning. To make this coil, wind a Formica tube three inches in diameter and six inches long with about 75 turns of No. 26 double cotton covered wire without taking any taps. Then, with a pencil and straight edge, make two parallel lines about ¼ of an inch apart along the coil, as shown at Figure 15 (A). With a red-hot iron, burn off the insulation from the wires between the two lines. Be sure that no two wires touch. Mount the coil between two uprights, as shown, and lead the wire from one end to a binding post. Next make the slider and slide rods. This may be done simply by cutting a strip of sheet brass about 1/32 of an inch thick in the form shown in Figure 16 (A) and bending it around a square brass rod as shown at Figure 16 (B). After it is shaped, slip it from the rod, and by tapping it gently at the point (C), bend it until it fits tightly upon the rod, but will slide readily back and forth. Slip the rod through it and mount the rod on the uprights with the tongue of the slider pressing firmly upon the bared wires. Solder one end of a flexible copper wire to the slider and lead it to a binding post as shown in Figure 15 (B).

If you are a good workman and have proper tools you can make a much neater slider in the manner shown in Figure 17. This consists of a block of brass bored to take two brass rods and with a tongue of spring brass or copper soldered to one side as shown at (A). A hole should also be bored through the slider to one of the holes for the rod and threaded to take a brass screw about ⅛ of an inch in diameter (B). This will serve to secure the slider to the rod when the proper position for tuning is found and will also make a good contact. A binding post should be connected with the ends of the rods as indicated at (C) in Figure 17. In either case the connections to the set are made as shown in the figures.

IN THE NEXT ISSUE:

How to Build an Efficient Loose Coupled Tuner



A LONG-DISTANCE EXAMINATION OF A PATIENT'S ORGANS
With the aid of the vacuum tube amplifier—as first demonstrated by Major General George O. Squier while he was but a colonel—a patient's heart action may be heard by the examining physician miles away.

The Thunder *of* Our Heart Throbs

How the Recent Development of the Amazing Radio Audion is Opening Up New Fields of Scientific Research.

By J. C. GORMAN

THE development of the vacuum tube or audion which has been made within the last five years and which has opened up so many fields of usefulness is of such commanding importance that it may properly be given first place over all other recent inventions of the twentieth century. Without it, our transcontinental telegraphy or telephony would be virtually impossible, and even transoceanic radio communication would be sadly crippled. The device has entered practically every field of scientific usefulness and its contributions to each of these fields are of almost inconceivable value.

One of the most important applications of the audion is its use as an amplifier. It is employed in the medical profession as an amplifier of the sounds of heartbeats and for detecting ailments that affect the working of other human organs. It is used to make the deaf hear.

It is used in electrical research laboratories for amplifying and measuring the feeblest of electric currents. It is used in ordinary telephony to strengthen weakening voice currents which have traveled great distances. It is used by college professors to amplify the tiny sounds that insects make. It also makes possible our modern radio telephony in its perfected form today.

The inventor of the amplifier, Dr. Lee DeForest, also created the three element vacuum tube which is now called the audion. One of his ablest assistants who has himself contributed invaluable service and ingenuity to the developments of both the audion and the amplifier, of which the audion is the backbone, is Mr. E. B. Myers, one of the country's most eminent vacuum tube experts and radio engineers.

Mr. Myers has done important research work in the largest laboratories throughout the country. In the development work during the war he was in the foremost ranks. Since the war he has been at work on the tube in his own laboratories, ever improving and perfecting it, he has probably conducted more experiments, made, handled, and studied more vacuum tubes than any other man outside of Cooper Hewitt himself. He has finally perfected and standardized an amplifying vacuum tube which is probably the peer of any other tube now made—the "radio audion." This device is remarkable in that it is of small dimensions, measuring only 3¾ inches in length, and ⅝ inch in diameter.

The tube contains the conventional three elements—the filament, the grid, and the plate—but its construction and electrical characteristics are new and give it its exceptional efficiency for radio work. These elements, which are of extremely small size, are all assembled and mounted on two Pyrex glass beads, with the wire connections running through the beads to the terminals at either end of the tube. Every bit of air or other gas is driven out of the metals that are used inside of the tube, before the assembly is put into its outer glass shell. The glass shell is then closed at each end, by an automatic machine that at the same time forms the glass into proper shape to hold the end terminals. Finally the tube is exhausted of all air or gases by a vacuum pump of special design. All of the parts are made by automatic machinery which insure uniformity in dimensions down to one-half a thousandth of an inch. The tubes do not vary more than two percent in physical dimensions.

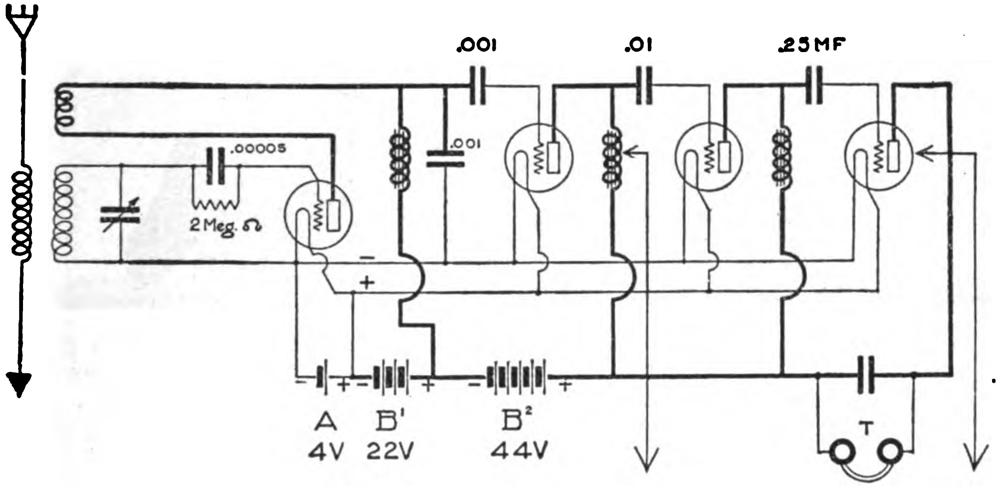
After the tube is exhausted of air and sealed, two terminal caps are fastened, one at one end and one at the other, and the tube has the appearance shown mounted in the illustrations. The tube is an excellent detector, although it is not sold or licensed for this use, and it is a wonderful amplifier and oscillator.

One special feature of the "radio audion" is the total absence of "tube noises." All of the other present day tubes give off a peculiar sizzling or frying noise, some to a much greater extent than others. This tube, however, is absolutely quiet when no signals are being received, even when used in multiple stages of amplification.

On account of the highly evacuated condition of the interior of the "radio audion," no ionization takes place when the plate voltages are increased over the 100 volt mark. In this way even greater amplification can be obtained than when using the conventional 45 volts on the plates. The amplification constant of the new tube is over four times that of the vacuum tube now in common use.

The filament is a spiral tungsten wire and is rated at .8 amperes at 4 volts. The tube will oscillate with as low as 3 volts on the plate; with 22 volts on the plate the normal space current lies between .6 and .8 milliampere. If a 4-volt battery is used on the filaments the ordinary filament resistances are entirely unnecessary, as the tube is truly non-critical.

When used with Myers' special amplifying coils and circuit, signals can be re-



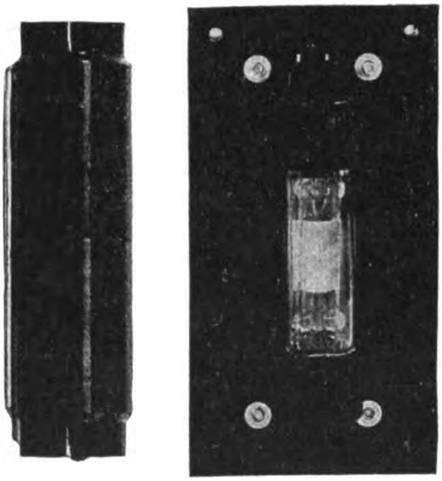
ceived with the utmost clarity and with terrific strength. Music and voice can be heard many hundreds of feet away when a loud speaker is connected to the output circuit of the amplifier.

The diagram, Figure 1, shows the method of connecting up the tubes and coils, and these instruments are supplemented by the use of four mica condensers which store up the instantaneous voltage supplied by the combined action of the preceding tube and coil. The next tube and coil take this voltage and step it up and supply it to the next set of tube and coil, and so on.

A .001 mfd. condenser is shunted across the plate to filament circuit of the detector tube to bypass the radio frequency currents. This condenser is important. Another .001 mfd. condenser is used in the grid circuit of the first stage. A .01 mfd. condenser is used in the grid circuit of the second stage, and a .25 to 1.0 mfd. condenser is used in the grid circuit of the third stage. It is necessary to shunt this last condenser with a 100,000 ohm grid leak to protect the last tube from "choking up."

With this type of circuit the phenomena known as howling is entirely absent.

The internal capacity of the tube is low, and this additional feature makes it function efficiently as a radio frequency amplifier on low wavelengths.



THE MINIATURE WONDER WORKER

The new coil (at left) and tube (at right), reduced to half size, and the method of installation that increases the radio signals thousands of times in strength.

At a recent demonstration when a loop antenna was used with "radio audion" tubes, in the cellar of a brick building, with three stages of radio frequency amplification and three stages of audio frequency amplification, such as described above, weak signals from a far distant broadcasting station were amplified to such an extent that the music was deafening, and the electrical energy in the plate circuit of the last stage was so great that a serious shock would be experienced by anyone who would have placed his hands across the output terminals.

WHAT is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to Editor, ADVENTURE IN THE AIR DEPARTMENT, *9 East 40th Street, New York City.*

I Find My Missing Pal By Wireless

TO the "romance of the sea," which has seized man's imagination from the days when our prehistoric ancestors dared not venture out of sight of land in their crude craft, has now been added the "romance of the air," filled with infinite possibilities. When these two elements combine to set a man in the path of adventure we get such experiences as this:

When Henry Marko sailed for the Mediterranean on the SS. *Princess Louise,* that was the last I heard of him. He had been my pal, but he had obtained his radio operator's license and away he went. Neither he nor the ship came back; they simply dropped out of sight.

Then came the first sea-going radio telephone set. It was installed on the SS. *Tyler* of the Old Dominion line, which has long since gone to her watery grave as a mine sweeper over in the North Sea. But at that time she was the newest and biggest ship of the line, and when her skipper heard that the first marine radio telephone was going to be installed on his vessel, he applied for another gold stripe for his sleeve.

It meant still more to me, as it was my first ship. Wireless operators were privileged creatures in those days, and naturally I was a proud youth when they fitted my uniform.

After we got the machine installed on the vessel and moving pictures had been taken of it, of the inventor, of myself and everyone else concerned from the Captain down, the *Tyler* got away from Pier 26, New York, and started to make her way down the coast.

As soon as we got outside the harbor, we began to establish radio telephone communication with the various wireless stations on the coast, and they answered us in the regular Morse code. Each station sent us messages of congratulation on the success with which we were able to transmit speech through the air. As we made our way down the coast, we tried for distance. Philadelphia answered and said he got us fairly well; that was about a hundred miles away. Later on that evening I began to pick up other ships.

Shortly before midnight I heard the "DDL" calling land. He sounded very faint, and I judged that he must be two or three days out. But he kept calling, and signing off "DDL, DDL." Some mysterious force led me to look up that call in the book, and I was amazed to find beside the letters DDL, the name of the SS. *Princess Louise.* It was Henry Marko's ship.

Hastily I started up our new machine and called the ship, speaking the name over and over again and adding:

"Is Henry Marko on watch?"

Then I shut off and listened in. Suddenly the DDL came back at me:

"Sure, Henry Marko is on watch; this is Henry now. Is that you, Jay? How are you, old man?"

I had not told him my name, but he had recognized my voice, although it later developed that he was several hundred miles away at the time. We sent messages back and forth which led to a reunion some months later in New York.

We will both remember the incident as long as we live. Henry told me that I nearly swept him off the chair when he heard my voice out there over the sea in the middle of the night.

Today Henry is holding down an important position in the Polish Radio Administration, and uses the radio telephone in the routine of his work over there in Warsaw.

E. JAY QUINBY

An Unrecorded Episode of History

A GLIMPSE into the routine life of a radio operator in the gonio stations behind the battle front is revealed in the dramatic experience of the writer of the following item—a man who won his commission as well as a citation for his work in the Radio Section of the Signal Corps:

In May, 1918, I was in charge of a radio compass station of the Signal Corps (known as a gonio station), at Menil-la-Tour. I had two operators with me, Corporal Helmick, and Private Clement; between us we maintained a constant watch during the day from 8 A. M. to 10 P. M. This period was considered sufficient for a gonio, as during this time practically every enemy station in operation would have transmitted, thus enabling us to secure its bearing from our station.

About the 26th of May an order came from our commander to keep a twenty-four hour watch at this station "until further notice." This was rather a difficult problem for only three men, but we decided to work four hours on and eight hours off until the emergency was passed, or until more men were sent to help us. It seemed rather an odd order, as there had been very little radio activity for the few days preceding and we could not understand the necessity of the extra duty.

The first twenty-four hours were monotonous. The next night I was on the watch from 10 o'clock to 2 in the morning. There was practically no transmission by the enemy. At 11 o'clock (midnight by enemy time), a high-powered station sent out the weather report as usual: I paid little attention to it. The minute he had finished, pandemonium broke loose; the air became a mass of buzzes and calls from every direction along the enemy front.

Naturally I was galvanized into action with a jolt as the foresight of our officers landed home with a crash. When 2 o'clock came, I rushed to our quarters and awoke Clement to relieve me; he was out of the door and on his way to the station in no time and the good work was continued.

In the three hours of this extraordinary activity, I had taken over 250 bearings; 150 to 200 bearings were considered a good day's work for the regular watch. At the end of the twenty-four hours, we had taken 670 bearings, averaged and forwarded them to the intelligence office at Chaumont.

We learned later that the order to maintain constant watch had been prompted by the drop in the curve of enemy activity, which was plotted from the number of bearings taken each day, at the G2 office at G. H. Q. On previous occasions it had been proved that there was a great decrease in transmission a day or so before an attack, and that was what happened in this case.

The enemy attack was on Seichprey, and the results are a matter of history.

Frank W. Ballard

The Radio Stops a Mutiny

"STONE walls do not a prison make" the poet tells us. Nor does a barricaded cabin or a vessel threatened by a rebellious crew necessarily keep its prisoner out of touch with help, as witness:

Sailing to Cuba has its compensations but the radio man on a sugar boat loading at a remote southern Cuban port is not always convinced of it. The only activity is at the loading pier; all there is to do is to watch the husky negro stevedores carrying the huge bags of sugar into the hold.

Not long ago a sugar boat was approaching one of these ports. The day was hot and the static exceptionally heavy. Suddenly the radio operator was startled by an S O S call.

It is a law of the sea that a ship must return to its home port at least once each year. One of the sugar boats loading at the port had been away from home for just that period. The captain had received orders by radio from the owners to take his cargo of sugar to Honolulu. His request to the crew to sign new articles had not been received in a kindly spirit. Instead, the captain found himself barricaded in his own cabin and his crew in mutiny. The stokers were starting up the fires and everybody was for going home, orders or no orders.

But the telephone between the captain's cabin and the radio station was in good working order. An S O S was sent out, and communication was established between the ship and the home office. The company authorized a bonus to the crew; new articles were signed, and a successful voyage to Honolulu resulted. Thus radio prevented a 2,500 mile voyage to the home port and back and enabled the company to realize a large profit on the cargo.

Edgar H. Felix

A Close Call for a Gonio Station

NOT all of a radio operator's adventures in the air reach him *via* wireless. Here is one, for example, that was literally delivered to the very door of a gonio station—by the air route, to be sure, if not by ether waves.

One of the most thrilling experiences I had while in France with the Radio Section of the Signal Corps was when the enemy shelled a railroad station which was about 500 feet from our barracks. The Germans were under the impression that ammunition was stored there; the fact that it was not did not help matters any as far as we were concerned, and several 12-inch shells were dropped too close to us for comfort.

We were housed in a small wooden barracks building at Royaumeix. As we had no dugout nearby we had been ordered to seek shelter in the event of shelling. One day three shells came over in rapid succession; then the shelling stopped. Thinking it was over we returned to our barracks, and I began telephoning in my morning report of gonio bearings to the intelligence office at Toul. I jokingly told the man at the other end of the wire what had happened, and warned him if I should suddenly stop talking he would know the reason. The words were hardly out of my mouth when I heard the whizz of another shell, followed by an explosion which I knew was close. As I was indoors, however, I did not pay much attention to it; indeed, I did not realize how close it had landed, and I went on telephoning my report—incidentally remarking to the man at the other end of the wire that another shell had come over. He replied that he had heard the report through the telephone. The next minute there was another report, followed by a mighty crash; it seemed as though the building would fall in splinters around me. This was accentuated by the noise of our alarm clock, which was jarred off a shelf and fell to the floor.

Without telling the man at the other end, I put down the telephone and went outside to see what was going on; at the same time I got my mask ready in case any gas should follow the shells. When I came back to the 'phone the man at the other end was shouting excitedly, convinced that I was done for, as he had heard the crash through the 'phone. I assured him that we were all right, and finished my report.

When I looked around the building to see what damage had been done I found that one of the shells had landed about fifteen feet outside the barracks, and in a line with the length of the building; some of the shrapnel had passed straight through from end to end, about five feet back of where I had been sitting. In passing through the shrapnel had cut slices through four thicknesses of blankets on my cot, and also picked up my cap from the cot and carried it along to the end of the barracks. One of the operators who had been on a night watch had been sleeping directly in line with the course of the shrapnel, but fortunately he had been aroused beforehand and was sheltered when the shell landed. When we later dug the nose of the shell out, the hole was deep enough for a man to stand in up to his waist.

FRANK W. BALLARD

A Band Concert on a Barbed Wire Fence

IT is not often that a radio amateur looks upon a storm with a friendly eye. But here is one in Wyoming to whom a storm brought a real windfall:

Such a curious phenomenon happened to me one windy night that I thought either that the ether had suddenly changed its density or that a great comet must be passing by and was affecting electrical conditions.

I was alone in my attic station, and no doubt the lonesomeness combined with the roaring wind had some effect upon my imagination. My set was not expensive and my aerial was so short that I seldom heard any stations other than those about Cheyenne, most of them amateurs. At times the blast of the wind which swayed the house and moaned heavily in the eaves drowned out all sounds from my receivers. It was one of the few heavy winds of the year, one of those which burst plate glass windows here and there on exposed corners and removed unstable chimneys or played havoc with the trees in the way.

A sudden blast made my chair shiver. I glanced out of the window at the inky darkness as I waited for the wind to quiet.

In the following calm I heard a band playing, loud and clear. I knew that it was a broadcasted program from Denver—the fulfillment of one of my dreams.

Another blast of wind shook the house. I went to the window to see what strange change was taking place in the earth's atmosphere. Then I listened to my receivers again, and my curiosity finally drove me out into the black night.

I found that the wind had blown one end of my aerial down and that it had connected with a barbed wire fence which evidently was not grounded. The fence served as a fine long aerial.

A. E. WILKES

HOW THE SUN HELPS WIRELESS

In the next issue Dr. E. E. Free will tell about the "wireless screen" about the earth—a startling new theory evolved by Dr. Flemming, the distinguished British scientist. Dr. Free is himself a noted scientist, a consulting chemical engineer by profession and a member of a dozen learned societies. In the accompanying picture he may be seen as the central figure, about to set forth on a flight of fancy into the solar regions.

WHAT READERS ASK

This department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask THE TECHNICAL EDITOR.

QUESTION: What radio equipment would you recommend for an amateur listener—to cost not more than $50.00?

DON HEROLD

ANSWER: The following list of materials and prices is given for your information:

One short-wave receiver	$35.00
" detector vacuum tube	5.00
" pair 3000-ohm phones	6.00
" 22 1-2 volt "B" battery	2.00
Four dry batteries	1.60
Total cost	$49.60

* * *

QUESTION: What is the correct size grid leak to use with a Radiotron detector tube?

R. T. OWEN

ANSWER: A 2 megohm grid leak is the correct size. This can be connected across the grid condenser or between the grid and the negative filament leads.

* * *

QUESTION: Which sends out the sharpest wave, a quenched spark transmitter or a modulated C. W. transmitter?

M. B. G.

ANSWER: The modulated C. W. transmitter has a smaller decrement or sharper wave.

* * *

QUESTION: What is the right size of transformer to use with a transmitter using two 5-watt tubes? The transformer should also have a filament winding.

A. SHARP

ANSWER: The two "5-watt" tubes will have a plate current of approximately 80 milliamperes on 350 volts. This is an input of 28 watts. The two filaments will draw 4.7 amperes at 8 volts; this is an input to the filaments of about 38 watts. The total energy required will then be 60 watts. In order to have a reserve capacity and allow for inherent losses in the transformer you should procure a 100-watt transformer.

* * *

QUESTION: What size of honeycomb coils should I use for a wave length of 360 meters? I have a 3-coil set but have no short wave coils, and I want to try the set on the broadcasting wave lengths.

L. DUGGAN

ANSWER: For the primary coil use an L-35, and for the secondary use an L-50, and for the tickler use an L-75. This will give you a wave length range from 180 to 800 meters with an antenna of average size.

* * *

QUESTION: My receiving set oscillates very nicely when I am listening on the detector alone, but when I use the 1st or 2nd stage of amplification, the set fails to oscillate and I cannot hear long distance C. W. Is there any way to rectify this fault?

CHAS. COOTE

ANSWER: This is because the reactance of the primary of the amplifying transformer is too high to allow the radio frequency currents to flow through it; therefor the set refuses to oscillate. Shunt the primary of this transformer with a .0005 mfd. condenser and your troubles from this source will be over. The function of this condenser will be to bypass the radio frequency currents around the transformer primary.

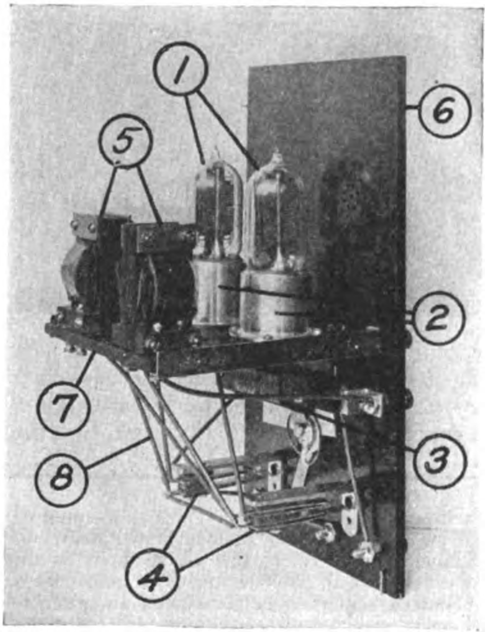


Figure 1: *The parts of a 2-stage amplifier.*

Question: Will you give me a diagram of a good design or arrangement of parts for a 2-stage amplifier?

Edward Lancaster.

Answer: The accompanying Figure 1 and Figure 2 shows a good design for a 2-stage amplifier. The parts are as follows:

1. Amplifying tubes.
2. Tube sockets.
3. Filament adjusting resistances.
4. Telephone jacks.
5. Amplifying transformers.
6. Front panel (Bakelite).
7. Instrument shelf.
8. Wiring.

* * *

Question: What is meant by the initials "C. W.?"

L. S.

Answer: "C. W." is an abbreviation for Continuous Waves. Continuous waves are used in radio telephony and telegraphy and are different from the radio waves produced by a spark transmitter in that they are continuous; that is, the oscillations that produce them do not vary in their amplitude or strength. The waves from a spark discharge die out between each discharge, but the continuous or undamped waves keep up to the same value steadily. Continuous waves cannot be heard unless the receiving is regenerative or an external heterodyne is used. This is why you hear nothing between the words that are spoken into a radio telephone transmitting set, although the continuous waves are still going; it is also why, when you turn the knob marked "Regeneration," on your set, you hear a shrill whistling sound. When you regenerate you start a continuous wave in your own set that combines with the continuous wave of the transmitting station, and the two waves interfere, so to speak, and produce the whistle.

* * *

Question: Sometimes, while tuning my set, I hear noises that sound like wind blowing. My wife suggested that probably the wind does affect the wireless. Is this so?

B. D. F.

Answer: The sounds that you heard were probably the continuous waves of a radio telephone transmitter. You were probably using too much regeneration while tuning in.

* * *

Question: How far apart should I put the wires in my antenna? I wish to put up a four-wire antenna.

J. H. Bock

Answer: The wires should be at least two feet apart. If you put them any closer together the additional wires will not give you any added efficiency.

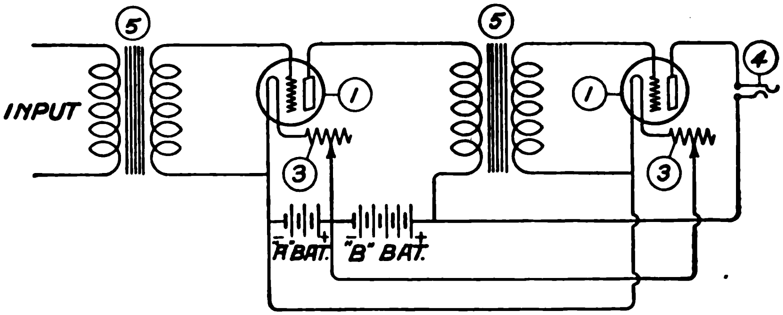


Figure 2: *A good design for a 2-stage amplifier.*

QUESTION: I have a number of radio instruments that were in use before the war; they include one loose coupler, a crystal detector (galena), one pair of 2000 ohm Marconi phones, and a 43 plate Murdock variable condenser. Can I make a set out of them that will enable me to hear the music that is floating around through the air these days? If so will you show me how to hook up the set?

E. A. P.

ANSWER: The diagram, Figure 3, answers your question. This set should receive a distance of twenty-five miles under good conditions.

* * *

QUESTION: What is the highest wavelength that an amateur is allowed to send out?

J. PELTON

ANSWER: Amateurs are now allowed to transmit on any wavelength on or below 200 meters. This regulation will be changed shortly to allow transmission by amateurs on wavelengths up to 275 meters.

* * *

QUESTION: I have tried the enclosed hook-up out of one of the daily papers without hearing anything at all as yet. Will you let me know if there is something wrong with my connections?

H. THORPE

ANSWER: The hook-up is correct in every detail except that the "B" battery is connected in the circuit in the wrong direction. This may seem unimportant but it makes all the difference in the world. Disconnect the "B" battery and switch around the connecting wires until you have the positive wire attached to the plate of the vacuum tube; then your set will work. The vacuum tube will pass a current in one direction only, therefore the battery must necessarily be connected so that the current will flow in that direction.

* * *

QUESTION: What time in the evening do the radio concerts start and how long do they last?

J. S. CONNERS

ANSWER: The radio broadcasting usually begins its continuous program at about 8.00 p. m. and it lasts till about 10.30 p. m. We would advise you to look in the daily papers as the programs of the broadcasting stations are regularly posted in their radio columns.

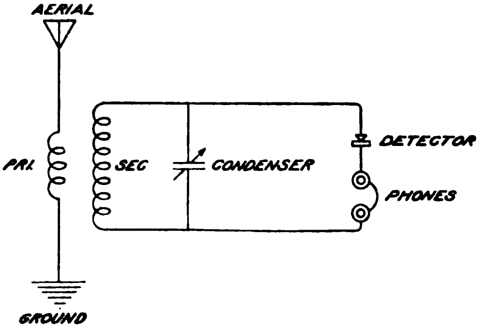


FIGURE 3: *A hook-up for a crystal detector.*

QUESTION: I now have a one-wire aerial, and I am wondering if I would get twice as good results if I were to put up two wires.

R. L. SMYTH

ANSWER: If you have a one wire antenna of 100 feet length or so, do not bother to put up another wire, as the results will be very slightly superior.

* * *

QUESTION: How many turns of wire and what size of wire and what diameter of cardboard tube would be correct to use for a one-slide tuning coil to receive up to 600 meters?

D. V. ESSEX

ANSWER: It would be best to use a Formica tube, 2½ inches in diameter, winding on it 60 turns of No. 18 enameled wire. The enamel can be scraped off where the slider is to run. A circuit diagram for this type of tuner and a crystal detector are shown elsewhere in this department.

* * *

QUESTION: What is the plate voltage necessary to have in my "B" batteries on my detector tube? I am using a Radiotron UV. 200 vacuum tube, and it sometimes gets bluish inside. Sometimes when I am getting loud signals it stops and then comes back again in a few seconds. Can you offer a beginner some suggestions?

R. DENTON

ANSWER: You have too high a voltage on your tube and consequently it "ionizes." The U.V. 200 requires between 16 and 22½ volts on the plate for most efficient operation. Get a variable "B" battery and vary the taps until you find the best setting. When your tube suddenly "shuts off" it is probably because you use too high plate voltages. Get a 2 megohm grid leak and connect it across your grid condenser and this trouble will be eliminated.

QUESTION: The filament of my audion has leaned over and touches the grid, and it will no longer operate. Is there any way to fix it or will I have to get another one?

D. ANDERSON

ANSWER: You may be able to jar the filament free from the grid by holding the tube in one hand and striking it on the opposite side of the tube from which the filament is bent over, against the palm of your other hand. The tube is worthless as it is, and sometimes the filament will jar itself free under this strenuous treatment although you will have to run the risk of breaking the glass bulb or the filament itself.

* * *

QUESTION: What is the most sensitive kind of mineral to use as a detector of wireless waves? I am now using Silicon and have been told that I might get better results from Perikon.

JOS. DAPHNE

ANSWER: The best mineral that you can use is Galena crystal. It is more sensitive and fairly easy to adjust. You may buy tested crystals which will guarantee you satisfaction for about 35 cents a crystal.

* * *

QUESTION: When I turn my variable condenser I get a scratching and scraping noise that is annoying. I do not know enough about electricity to be able to locate the trouble. What is the matter with it?

H. M. PICKEN

ANSWER: The trouble is probably in the condenser itself. Take the condenser out of the set, hold it up to the light and look through in between the plates and slowly revolve the knob; you will find that one of the plates attached to the rotor shortcircuits with one of the stationary plates. You can then straighten the crooked plate with a knife blade.

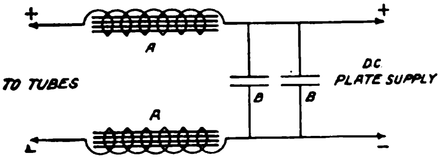


FIGURE 4: *A filter circuit for an alternating current radiophone.*

QUESTION: I wish to become affiliated with an amateur association that is national in scope and that has the interests of the country's young radio men at heart. Is there any such association? If there is how can I get in touch with it?

A. I. BEARD

ANSWER: The American Radio Relay League is an association of the amateurs, banded together for furthering the interests of citizen radio. You may get in touch with it by writing to the American Radio Relay League, Hartford, Conn.

QUESTION: The other night I forgot to throw my lightning switch and got up out of bed to do so; just as I threw the switch I noticed a little spark as the switch closed. I immediately opened the switch a little distance and sparks jumped across the switch regularly. I had no batteries connected to the antenna at all, and cannot see where the current came from. An amateur friend of mine told me that it was the static and I would make a better acquaintance with it some time during the summer. Was he joshing me?

E. R. ROYCE

ANSWER: What your friend told you was true. Static is natural electricity that accumulates in the different strata of the ether, and when your antenna is not grounded (or in other words, when it is disconnected), it acts as a condenser and charges up these natural voltages until a high voltage is accumulated. If the switch is not too far open this voltage will discharge to ground in regular intervals in accordance with the time it takes for the antenna to charge up to the voltage necessary to jump the gap at the switch.

* * *

QUESTION: Will you give me data for a good filter circuit for my new alternating current radio telephone?

ELMER HORLE

ANSWER: The filter circuit as described in Figure 4 will help you as it is simple and easy to set up, and good results will be obtained by its use. The materials you will need are:

A; 2. 1½ henry choke coils.
B; 2. 1 mfd. 1000 volt paper condensers.

This filter circuit should be connected directly across the plate voltage supply.

ITEMS *of general interest that you ought to know; bits of information of practical usefulness to every radio amateur.*

Three Amateurs in 200 Are Licensed to Transmit

Do you think that the "radio fan" is a new arrival? The fan himeslf can tell you otherwise—although it is only within the past few months that he has become so amazingly numerous. In 1920 there were about 10,500 licensed amateurs in the country; last year there were 13,560. Amateur radio stations that receive only are not included in the licensed list; of the latter it has been estimated that there are 600,000 to 1,000,000 now in existence, while a year ago there were not over 60,000. The pre-war peak was in 1916 when the number of licensed stations was slightly over 5,600. During the war there was a large drop in the number because all but official stations were prohibited. In 1904 the money invested in the production of radio telegraph instruments was only $114,050 and in 1919 the amount had risen to $7,600,698.

Can Radio Waves Start Fires?

THE mysterious fires at the MacDonald homestead near Caledonia Mills, Nova Scotia, thirty-eight of which fires started somehow in a single night, were *not* due to radio waves.

This is the verdict of Doctor Walter Franklin Prince, distinguished investigator of psychic phenomena. Following the wide newspaper publicity given to the alleged supernatural occurrences at the MacDonald farm, Dr. Prince was delegated by the American Society for Psychical Research to make a thorough investigation. He spent six days at the supposedly haunted house examining all phases of the reported phenomena. His official report to his Society is now available and disposes finally of the idea that radio had anything to do with the fires.

In addition to his final report, Dr. Prince has made the following statement especially for POPULAR RADIO:

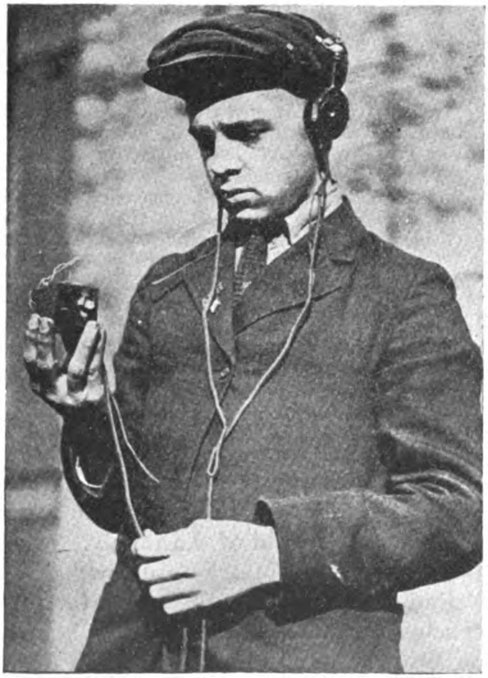
> "The results of my investigation entirely exploded the idea that radio waves caused the fires in Antigonish, unless it be conceded that the waves were intelligent and had the power of transporting objects from one part of the house to another. A sofa cushion was carried downstairs before it was set on fire and pieces of cloth were stuffed into boxes and put into odd places before they were set on fire. The waves would also have to be discriminating enough to avoid setting fires unless persons were in the house and to avoid the upper part of rooms higher than a girl five feet tall could reach."

Dr. Prince concludes that the fires were set by humans; probably, as his formal report shows, by Mary Ellen MacDonald, foster-child of the family. Anyway, radio had nothing to do with it.

Radio fans will breathe easier for this conclusion. If the barn happens to catch on fire they will be able to blame it on father's pipe and exonerate their wireless. Yet there is one question which wireless enthusiasts must consider:

When the radio theory of the Antigonish phenomena was printed in the newspapers most of the wireless experts, including Marconi, refused to commit themselves as to its impossibility. They were skeptical, but, with a few exceptions, they were not dogmatically against the idea. Does this mean that the idea is a possibility, that wireless waves, under any conditions, might set fire to homes or to anything else?

Probably not. No one knows of any way in which wireless waves could set fires or even produce the tiniest sparks, in wood or wall paper or brick, or in any ordinary building material. While it is true that the steel frames of office buildings might serve, theoretically, as receiving antennae, these frames are always well grounded and could not become charged to any significant voltage. The refusal of wireless men to say flatly that the radio theory for the Nova Scotian fires was absolutely impossible was merely a proper scientific caution in the face of unknown facts. In the light of general theory as well as of Dr. Prince's investigations, we need not be afraid of fires from stray wireless—at least until some new evidence comes to hand.



A $3.00 RECEIVING SET

A sixteen-year-old lad in Cincinnati made this miniature apparatus himself; he uses his umbrella as an aerial. It is reported to receive signals up to fifty miles.

The Radio As a Peace Maker

THE broad significance of the radio for bringing together into some semblance of mutual understanding the many and conflicting racial elements of the world—particularly during this trying period of readjustment following the war—is occupying more and more of the serious consideration of those in whose hands the destinies of the nations lie. Never before in history has it been more necessary to keep these many elements in touch with one another, and through a knowledge of one another inculcate an interest and friendliness and eventually that confidence upon which international amity must be based. And never before in history has the means been available to bring about such a condition so quickly and at so moderate a cost of money or labor as is offered by the radio.

Hawaii and the Philippines, to cite a case near to home, have sent urgent representations to Secretary of War Weeks and to both Houses of Congress, asking that the use of the naval radio systems for the transmission of press messages be extended for another five years. Both Territories maintain that a discontinuance of the service at this time would result in a serious curtailment of the news despatches sent to the islands, as the commercial rates today are practically prohibitive, with the result that communication between the United States and these two territories is reduced to a minimum at a time when it should be extended.

Great Britain, too, is planning a system of inter-colonial communication by radio that will link the homeland with her most remote dependencies. The Im-

GRAND OPERA IN THE ENGINE ROOM

Life on the tug boats in New York Harbor will lack monotony now that the New York Towboat Exchange has installed receiving sets on some of its craft. This picture was made on the good ship Nautic.

perial Wireless Telegraphy Commission has recommended that a series of thermionic valve plants be located at the transmitting stations of Great Britain, the Dominions of Canada and New Zealand, the Commonwealth of Australia, and the Union of South Africa; other stations located at such places as East Africa, Hong Kong and Singapore will have combined arc-valve transmissions. It is estimated that the thermionic valve sets will be able to transmit continuously ninety words a minute to a distance of 2500 miles, full power. The value of such a system to the Empire, in sending news and for the transmission of official and commercial despatches, can scarcely be overestimated.

The world is being brought together on a scale never before possible.

How to Talk on the Radiophone

To secure the greatest range and get the best results from speakers unaccustomed to talk over the radiophone, the Bureau of Engineering of the Navy is advising speakers who are to deliver addresses by broadcasting to observe the following rules:

1. Hold the lips about an inch from the mouth-piece of the phone and avoid turning the head away from this position while talking. If a manuscript is to be read, place it where it may be read without moving the head.
2. Speak in a strong, even tone.
3. Speak slowly, enunciate clearly and pause frequently. If the voice is naturally pitched low, raise it to a higher pitch when talking into the phone but do not shout. A strong steady voice pitched not too low, and a careful enunciation with slow speech carries best.

High Scores By the Navy Radio

THE proficiency of Naval radio operators was proven recently when a competitive radio drill was held among the destroyers of the Pacific fleet. Of the seventy-three ships represented, six squadrons secured 100 per cent, and one 99 per cent. Not one had a record below 83 per cent.

"How Far Can I Hear?"

A BUYER of a small crystal receiving set recently returned his purchase to the salesman of a New York retail store and demanded his money back on the plea that the apparatus did not function in accordance with the claims made for it. When his claim was refused he beat up the salesman—and the incident reached the newspapers by way of the police courts.

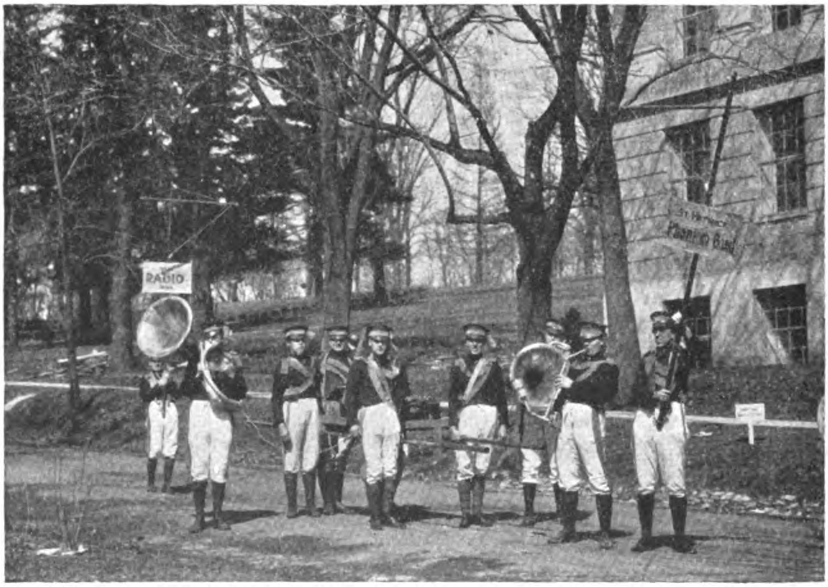
Laymen who have bought inexpensive little sets with the hope of listening in on broadcasting programs that come from any considerable distance will regard the item with sympathetic interest. The small crystal receiving set has its useful and proper purpose, but it also has its limitations; while it has occasionally received over two or three hundred miles under exceptional conditions it can seldom be relied upon to receive over twenty-five miles, and the virtues sometimes claimed for it by enthusiastic but misinformed salesmen will lead to disappointment if the words fall upon credulous ears.

It is but natural for the inexperienced customers in New York, for example, to inquire: "Will I be able to hear Pittsburgh and Schenectady if I buy this set?"

The question, however, is about as capable of a definite answer as; "How far can my voice be heard?" A man who speaks from the stage of the Metropolitan Opera House will be heard clearly in the rafters if he has the field to himself, but if he talks in competition with the orchestra his voice will be drowned out entirely.

Similarly the receptive powers of the radiophone are subject to innumerable external conditions. Given a clear night and an unusually free ether, the instrument may pick up messages from points that are far outside the normal range. On the other hand, an atmosphere surcharged with static electricity, the proximity of tall buildings or faulty construction of the antenna may prevent the proper functioning of the instrument.

The best way to even approximate the distance an instrument can receive is to hook it up and watch it closely for a week or so.



THE FIRST "RADIO BAND" IN THE WORLD

A group of engineer students of the University of Wisconsin carrying a receiving set equipped with horn amplifiers that gave out band music broadcasted from station 9XM on a phonograph.

Fotograms

WHAT ARE THE ETHER WAVES SAYING?

This youthful and distinctly modern Izaak Walton has something more on his line than a mere fish. A small and easily-transported aerial will solve the problem of many a lone fisherman now that the radio has come to help while away his spare hours

Radio from the North Pole

How would you like to listen to the messages of an explorer telling of his daily progress into the frozen north and perhaps finally talking from the North Pole itself? It is possible that the radio amateur may experience such a thrill in the not far distant future, for Captain Roald Amundsen, famed as the discoverer of the South Pole, announces that he will carry with him on his proposed expedition to the North some powerful radio instruments, with which he hopes to keep in communication with civilization—meaning certain parts of the United States and Canada.

Two thousand miles above the North American continent this descendant of the Vikings will sit at his transmitter in the cabin of his vessel, and may conceivably chat with his friends in Washington and Christiania, telling them of his adventures.

Amundsen's discovery of the magnetic pole several years ago was an achievement of moment in the world of electricity.

Will Radio Alter Our System of Weights and Measures?

Will the constant use of the terms "meter" and "gram" by the radio amateurs of this country create a sentiment in favor of the adoption of the metric system of weights and measures? That is what the advocates of the Ladd-Britten bill believe; indeed, they regard the rapidly increasing number of radio fans as a factor to be reckoned with when the issue comes to a head as to whether or not the United States will use the same standards of measurement as are used in Europe. Curiously enough, all of the electrical units are based upon the units of the metric system instead of upon the more complex American and English systems.

Intercollegiate Debates by Radio

The radio amateur may yet prove to be the connecting link between Harvard University and the Middle Western colleges which aspire to associate with New England's proudest institution of learning. Ashland College, located at Ashland, Ohio, has started the ball rolling by challenging Harvard to a series of debates to be carried on by radio, and it is reported that this contest may take place early in the autumn semester.

An Official Broadcasting Station for Uncle Sam

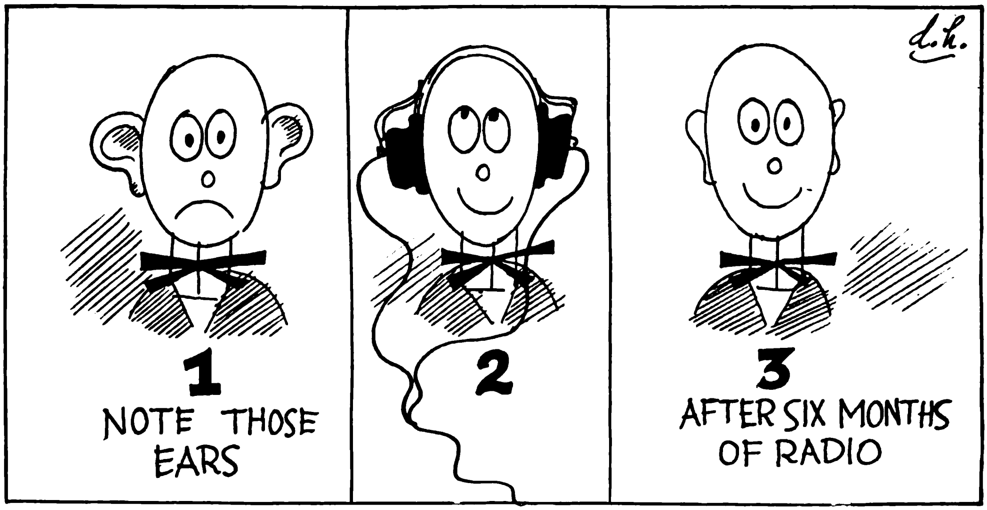
A POWERFUL radio-telephone sending set that will be able to carry the voice of President Harding and other governmental officials to practically all parts of the eastern and middle western United States is being installed in the naval radio station at Arlington. By the time this magazine is published it is expected that Arlington will have started a regular broadcasting program on a wavelength of 2650 meters.

Heretofore this large radio station which has day and night for years kept official Washington in touch with its navy and other outlying government functions, has not had radiophone equipment. The installation of the radio telephone became known only because of test messages that were sent; these messages were received perfectly as far away as New Orleans and Bar Harbor, Maine. Officials estimate that the ordinary range of the station is about 1500 miles, but it is expected that it will be possible to receive its broadcasting at much greater distances.

It has been intimated that Arlington, with the aid of this new equipment, will be the broadcasting center for important governmental announcements, such as presidential addresses before Congress, and it is even possible that the proceedings of Congress will be sent into the ether through this station.

The new Arlington set will be much more powerful than the Naval Air Service Station at Anacostia, D.C. which was used by Senator New in his famous speech to his constituents in Indiana. This station has only a normal range of 150 miles.

Arlington now sends out official U. S. Naval Observatory time signals at 10 o'clock each night with a spark telegraph set on 2650 meters, and its regular code working equipment is an arc transmitter on 3950 and 5950 meters.


d.h.
1
NOTE THOSE EARS
2
3
AFTER SIX MONTHS OF RADIO

One of the advantages of owning a radio set—as discovered by the well-known humorist, Don Herold.

THIS *department—conducted by a patent attorney of wide experience in radio work—will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

New Developments of Condensers and Variometers

Patent No. 1,408,738: Guy Hill, Washington, D. C., Electrical Condenser.

Patent No. 1,408,992: Joseph W. Doron, Hamilton, O., Variometer.

WHAT is a "condenser" or "capacity?" What is a "variometer" or "inductance?" Why are such devices always used for tuning radio circuits? What is their action? How many know that when we speak of "radio tuning" we mean in fact a tuning in the sense of or analogous to the tuning of a violin string?

We are all familiar with light waves and sound waves which are propagated in space and originate from vibrating particles or bodies. Then there are heat waves, X-rays, electromagnetic waves, all propagated by vibrating particles or by electrical oscillations. All waves, including electromagnetic or Hertz waves, follow laws which are similar, whether for light or electromagnetic waves or even for sound waves.

Such laws can be expressed mathematically by formulae, and from what is known about light or sound waves, facts may be deduced about other waves, such as the electromagnetic waves.

These electromagnetic waves can be sensed indirectly by their effects on sensitive instruments or apparatus; they cannot be seen or heard or felt. Can we picture in our minds electromagnetic or Hertz waves? Were we to attempt such a mental picture we would but see some tangible form of wave such as ripples on water.

As science, however, has studied electromagnetic waves by the effects they produce upon instruments and apparatus and as these effects are much like the effects and characteristics of water waves, sound waves and light waves with which we are more familiar, we may understand radio waves and answer the question above analogically in terms of sound waves and take as our example a vibrating violin string as representing a radio receiver.

The formula (and its explanation is simple) for a vibrating string is:

$$N = \frac{1}{2}\sqrt{\frac{T}{L\,M}}$$

All this formula means is, that, as determined by experiment, the frequency N (the number of vibrations per second) varies directly as the tension T on the string and inversely as the length L and mass M of the string. We all know that a higher note is obtained if the string be tightened and that the longer and heavier the string the lower the note. Another observation with which we are all familiar is that when the note C is sounded near a string tuned to the same note C, the latter will start vibrating also, but, if any other note is sounded the string will not respond. In the first case the sound waves set up in the air by the transmitter (the voice) affects the tuned string (the receiver) and sets the latter to vibrating. This sympathetic response only occurs when both the transmitter and receiver are in tune as determined by their tension and mass so that their periods are identical and co-operative, thus producing resonance.

As the vocal cords vibrate and set up sound waves in the air, so a radio transmitter, by means of the electrical vibrations therein, generates electromagnetic waves in the ether (like light or sound waves). When these waves strike a receiving aerial they are transformed again into electrical vibrations in the aerial—if the latter be tuned to the pitch or the wave length of the transmitted impulses.

Just as the frequency N of a string is determined by its opposing or co-operating forces of tension, the tension T, and inertia, mass M, so also the frequency of a radio receiver is determined by the opposition or co-operation of electrical tension, capacity C (a condenser) and electrical inertia, inductance L. Hence when the square root of the product of the inductance and the capacity of the receiving circuit equals the square root of the product of the inductance and the capacity of the transmitter the two circuits will be in resonance or tuned to each other.

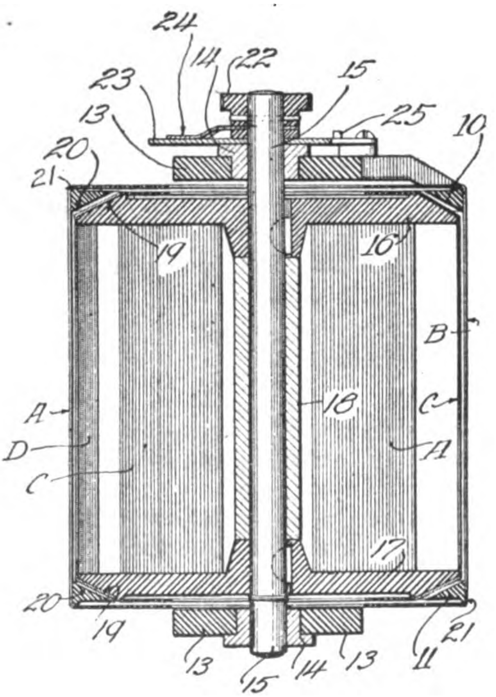


FIGURE 1.

A variometer is composed of a stationary coil and a rotating coil which can be turned so that its poles are either in the same direction as the stationary coil (thus giving the largest inductance value), or turned so that its poles are opposed to the poles of the stationary coil (thus giving the smallest value of inductance).

Thus it is evident that a receiving circuit may be tuned by adjusting either its inductance or its capacity or both.

Although any wire conductor has natural distributed inductance and capacity, yet it is preferable to insert in a receiving circuit lumped or artificial inductances and capacities, thus artificially securing the required relation of capacity and inductance by adjustment to receive different wave lengths.

All conductors that carry currents have self-induction, inasmuch as they are surrounded by magnetic fields and are therefore inductances. The production of this field creates an E M F or potential in the circuit in opposition to the potential or E M F that causes the current. This tends to retard the starting, change or stopping of a current in the circuit, which is a form of inertia. Coils have greater self-inductance by reason of their strong magnetic fields than straight wires, as is obvious from the extensive use of them as electromagnets; hence they are used in different forms as inductances in radio circuits.

Such inductances may be varied by several methods, such as by sliding contacts or switches, which are more or less complicated.

A variometer is one form of inductance which is continuously variable and which requires neither sliding contacts nor switches. It comprises two coils connected in series and mounted to rotate relatively to each other. When the coils are so positioned that their magnetic fields are opposed they will have substantially zero inductance and in the opposite position they will have maximum inductance. A variometer since it is continuously variable may be used to secure close tuning in a receiving circuit or it may be used as a combined tuning and coupling element.

Patent No. 1,408,992 illustrates a variometer of the above described type. This variometer as illustrated in Figure 1, comprises an upper fixed ring 10 and a lower fixed ring 11 having beads 21 on the upper and lower edges. Bridging members 13 are secured to the rings 10 and 11 and support the rotatable shaft 15. To shaft 15 are sécured the plates 16 and 17 which are spaced from each other by means of sleeve 18. The plates 16 and 17 have beveled edges 19 which face similar beveled edges upon the inner surfaces of rings 10 and 11; these edges are sufficiently spaced to allow the coils to be passed between them. Coils A and B are wound around rings 10 and 11, engaging the fixed parts upon the beads 21 only. The coils C and D are wound around the plates 16 and 17 and engage the flanges 19. The coils A, B, and C, D. are connected in series with each other.

One feature of the variometer covered by this patent is the small air space or gap between the stationary and movable coils; another feature is that a minimum portion of each coil engages the supporting structures although the latter are of insulating material, thus insuring maximum inductive effect and ,low losses, while providing a simple and economical structure.

A tuning inductance such as the variometer here described increases the fundamental period of oscillation of the receiving aerial, making it responsive to longer wavelengths than that for which the aerial is designed. The insertion of a capacity or condenser in an aerial designed for a given fundamental wavelength, on the other hand shortens the fundamental oscillating period and makes the aerial responsive to shorter wavelengths. This is analogous to the violin string, because increasing the mass increases the period of vibration and increasing the tension decreases it. By "period of vibration" is meant the time required to make one complete vibration. Inductances retard the oscillatory movements while capacity accelerates them.

A condenser is a device for storing electricity in electrostatic form and which, when charged, becomes tensioned, a mechanical strain or tension being imposed on the dielectric. Because of this strain there is an opposing force developed tending to release the strain as the condenser becomes charged. In its simplest form a condenser comprises a pair of conductors separated by a non-conductor or dielectric. The well-known Leyden jar is one of the earliest examples of a condenser. Condensers may have a solid dielectric such as mica, a gaseous dielectric such as air or even a vacuum dielectric. Air condensers are valuable because they may be easily adjusted and hence are suitable for tuning receivers.

While variable air condensers have been used for years, nevertheless refinements of design are continually being made for the purpose of making them more sensitive and in order to minimize losses therein when used with the high frequency currents that are prevalent in radio.

In Patent No. 1,408,738, Capt. Guy Hill, of the Signal Corps, U. S. A., has devised for a condenser a form of bushing which prevents brushing or discharge and breakdown of insulation between parts at a difference of potential.

Such variable air condensers as are here illustrated generally comprise the metal end members or supports A and B, between which are supported the spaced fixed metal plates 12 mounted upon rods 11 and spaced by washers 10 in the usual manner. The movable metal plates 13 are secured to a rotatable shaft 20 and are spaced from each other by the washers

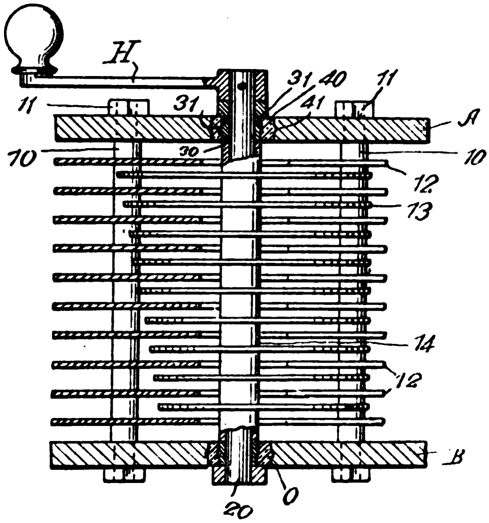


FIGURE 2.

A variable condenser consists of a number of stationary semi-circular plates that have a number of insulated rotating semi-circular plates spaced alternately between them. The capacity is varied by rotating the plates and thus varying the amount of surface of the movable plates exposed to the stationary plates.

14. The movable set of plates and shaft 20 must be insulated from the fixed set of plates and the mounting A B. Capt. Hill secures this insulation by interposing a moldable insulating material 40, such as electrose, between the bushing 30 in which shaft 20 is journaled and supports A B in such a manner as to secure intimate contact between the metal and insulating parts to the exclusion of air. This construction is obtained by serrating or roughening the surfaces 31 and 41 of bushing 30 and supports A B and then molding the bushing into place with moldable insulating material under pressure. When the bushings 30 are once molded into place they are held securely, making a strong mechanical construction. By the elimination of air from between the metal and insulating material, brushing and breakdown are prevented, as it has been found that a composite dielectric consisting of two different materials such as electrose and air is more liable to break down and deteriorate than a single good dielectric. This is exemplified in the manufacture of sheet condensers in which every expedient is used to remove the air from between the insulating sheets and foil. The construction proposed by Capt. Hill appears rather expensive to manufacture but it should be of value where high frequencies and high potentials are employed.

Just as the frequency or vibration of the violin string is caused by the tension of the string, tending to move it in one direction, and the mass of the string which by reason of its inertia (a characteristic of matter) tends to oppose this motion, so also the frequency of the electrical oscillations (the vibrations of the electrons) in a receiver is determined by the opposing electromotive forces of the inductance and capacity that tend to move the current in opposite directions, resulting in an oscillatory movement. The action may be likened crudely to two boys throwing a ball back and forth, the boys representing inductance and capacity (or inertia and tension) and the moving ball representing the oscillations or vibrations. A better example is the action of water in a U tube, oscillating back and forth under the opposing forces of gravity and inertia, the U tube representing the circuit and the water the electric current, and inertia representing the inductive forces and gravity the condenser forces.

The wave length of a Hertz wave, sound wave or light wave is equal to the velocity of the wave (which is a constant and approximates in the case of a Hertz wave the velocity of a light wave, 300,000,000 meters a second) divided by the frequency or oscillations a second. The greater the frequency of the oscillations a second the less the period of vibration and *vice-versa*.

Thus, when the receiver has its capacity and inductance properly adjusted to those of the transmitter, it is in tune and responds to the oscillations of the transmitter.

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Popular Radio

vol 1

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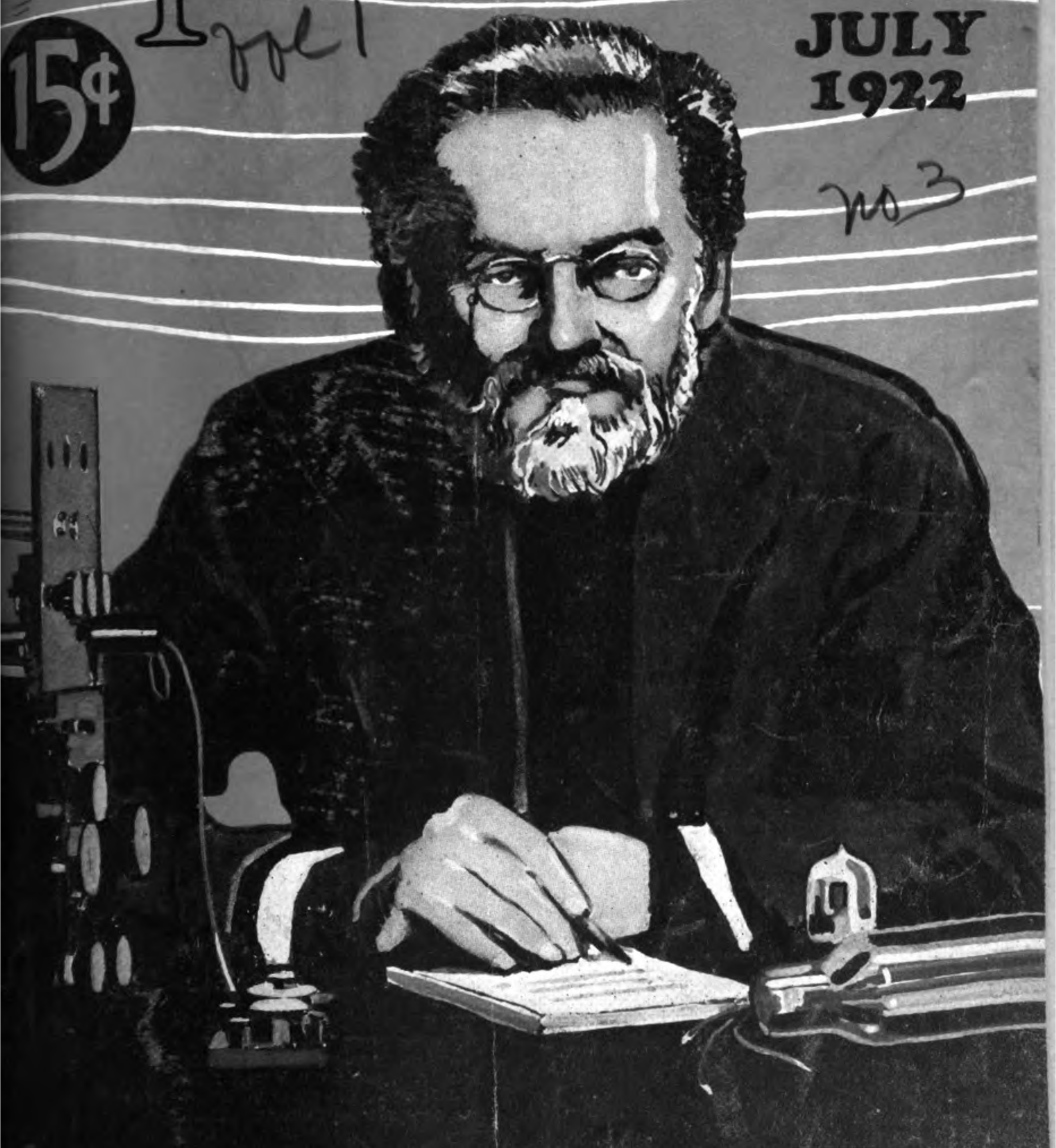
JULY
1922

no 3



THERE ARE NO ETHER WAVES

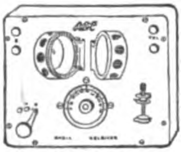
A new and revolutionary conception of radiant energy that demolishes present-day theories of electromagnetic wave motion

By Dr. Charles P. Steinmetz

ABC UNITS

Standardized Radio — *Sectional Receiving*

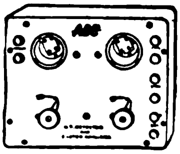
THE three ABC units here shown form the ideal combination for a receiving set. They may be purchased one at a time if desired, enabling you to add to your station at any time without discarding any previous equipment.



No. 5010

Crystal Detector

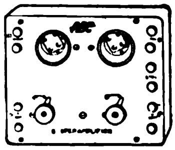
This first unit is capable of receiving wireless telephone up to 25 miles. The only accessories needed are the "completion package" and 2,000 Ohm head set, making the total price $40.00



No. 5013

Combination Detector and Amplifier

The first two units make a vacuum tube outfit capable of receiving wireless telephone up to 150 miles. Price $37.50: and for both units complete, except storage battery . . $94.70



No. 5014

Two-Step Amplifier

The third unit will increase the range and signal strength of the two previous units very considerably. Price for this unit alone, $45.00: or for the three units complete, except storage battery, $155.55

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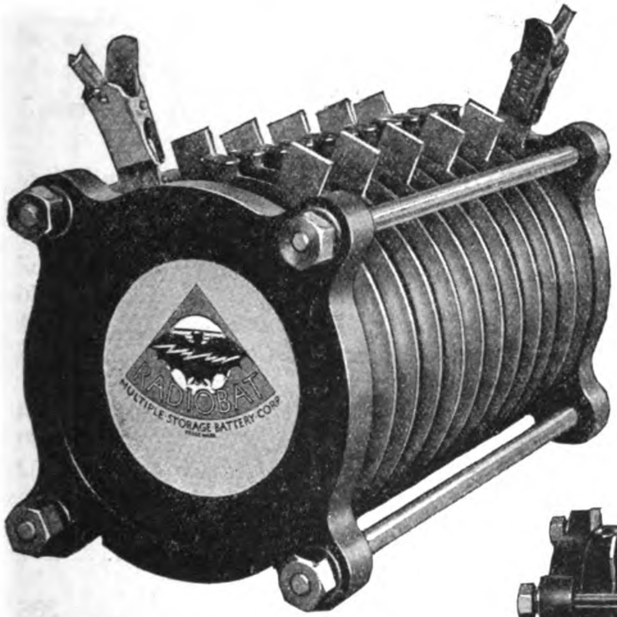
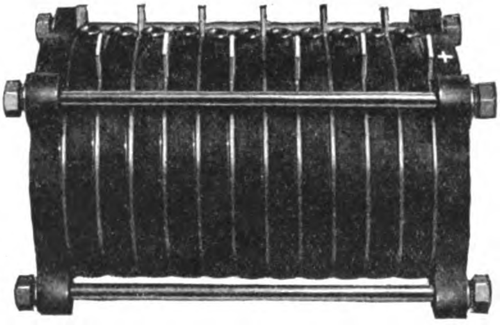
RADIOBAT "B"



The Most Remarkable "B" Type Radio Battery

Revolutionary in Design and Construction



Radiobat "B" is practically everlasting. It has no glass to break, no wooden case to rot, no separators of any kind. Radiobat "B" is leak-proof, it is free from acid fumes.

Any voltage desired can be obtained **simply and easily. Radiobat "B" will give a clearer tone to your Radio.**

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POPULAR RADIO

VOLUME I

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(Cover design by Charles B. Falls)

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KENDALL BANNING, *Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

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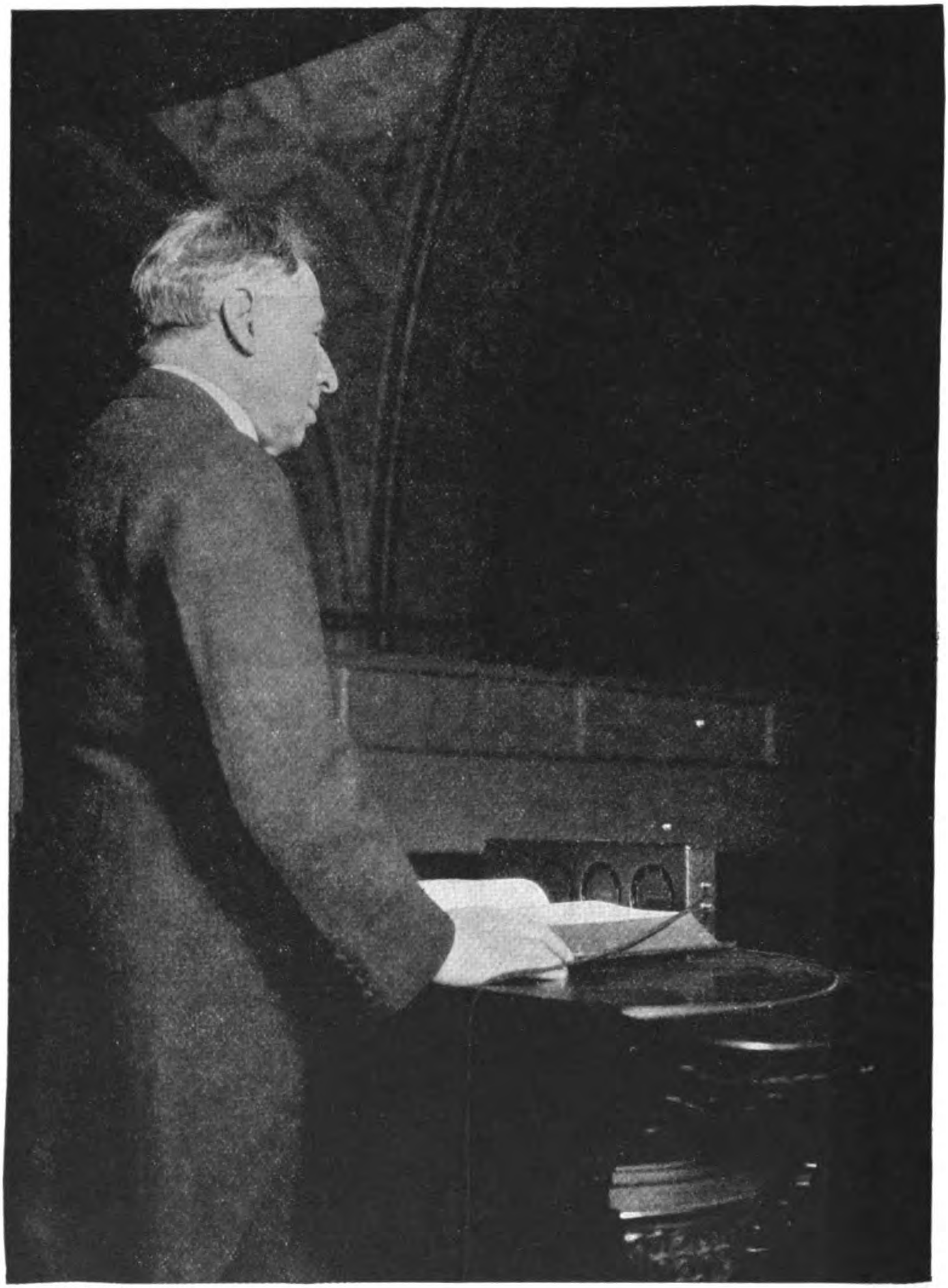
IF *one of our amateurs should pick up a radio message sent out to us from some planet circling a sun on the far frontiers of the Milky Way he would know that the sender of the message lived and died more than* 25,000 *years ago and that the message had been on the way all that time, and this, too, coming at the speed of light—* 186,000 *miles a second. For the light by which we see such a star left there* 25,000 *years ago.*

—HUDSON MAXIM



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A SERMON THAT WAS BROADCASTED OVER AN AREA OF 12,000 SQUARE MILES

By means of the four microphones connected in multiple on the pulpit, the voice of Dr. Charles Wood of Washington, D. C., was converted into electrical current that was transmitted by radio from a station in the church loft over a distance of 350 miles in all directions. Is the radio hurting the church? Turn to page 176.

Popular Radio

VOLUME I JULY, 1922 NUMBER 3

Radio: *the* World's Peace-Maker

Is Wireless Destined to Succeed Where Statesmen Have Failed in Bringing the People of the Earth into Understanding with Each Other? So Thinks the Distinguished World-Correspondent—

WILL IRWIN

IT was two summers ago. Teddy, who lives just behind me in the country, had been exceedingly busy these many weeks. I know young Teddy as a mechanical marvel, and having myself been born without dower of a mechanical sense, I admire his activities without investigation. I did notice him dimly, at different times, in the act of nailing wires along the flag-pole, and digging some kind of trench by the back door. Also, I found him at his chum Kilby's making a trade for a worn-out automobile battery.

"Whatever is he up to now?" I asked Kilby.

"Wireless telegraphy," said Kilby.

"Gee, the kid's ambitious," I remarked. As I remember it now, I had heard only recently that you could telephone without wires.

The day of the Carpentier-Dempsey fight arrived, and I was marooned in the country. I was trying to work pending the hour when I should telephone to Boston for news, when Teddy strolled in.

"Want to hear the returns from the fight?" he asked. "Got the old box tuned. They'll be talking from the ringside in ten minutes."

I flew to Teddy's room. He slipped on his headpiece, did some mysterious testing; I slipped on mine. A voice, far clearer and more natural than any I had ever heard over the conventional telephone, was saying:

"Carpentier has just entered the ring!"

When the excitement was over, I expressed to Teddy my fulsome admiration—plucking official dispatches out of the air in that way. Teddy received my compliments modestly. "All the fellows are doing it," he said.

I didn't really believe him. It was only last winter, when the newspapers began to burst out with radio columns, when Hoover held his conference in Washington, when the statisticians announced a million receiving outfits in the East alone, when I found the term "ether hog" embedded in American slang, that I realized how a new force of civilization had been slipped over on my generation. The newer generation is always doing that to the elder, I suppose. Probably along about 1830, middle-aged gentlemen heard with dim interest that people were starting railroads, and noticed next that stage-coaches were beginning to disappear. The

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THE NEW PIONEERS OF PEACE

The average amateur receiving set has a range of about 200 miles. What effect will this have in bringing together the nationalities of crowded Europe?

younger generation is forever remolding the world under our noses; but we have on our reading glasses and cannot see.

I have been speculating of late on this new agency of civilization; I have even tried to make out the slang of the craft in the radio columns. And I am wondering if we have not found this time a thing bigger than we know. A steam-engine turns wheels or lifts burdens. A locomotive draws, an aeroplane carries material things. But this device distributes speech, which is thought made audible, and thought is the basis of everything. Before the war, some expert on transportation calculated that any two given places on the earth's surface were eleven times nearer than they were a century before; hence the necessity for that growth, so marked since the war, from nations to alliances and finally toward some system of general world federation. But here we are in process of bringing all points in the world so close together in this important matter of speech from man to man, that virtually no distance intervenes at all.

I am quite aware—moron though I am in the matter of mechanics—of the mechanical limitations in this stage of development. I know that the million radio enthusiasts on our Atlantic coast are only listeners, not speakers, that the present receiving radius for a set within the means of an ordinary boy is only two hundred miles or so; that we have not solved the problem of unlimited numbers of conversations. However, he who says that all the limitations cannot be conquered rates himself, to my mind, with those who said in 1810 that a locomotive traveling twenty-five miles an hour would kill all its passengers by "air suction" or those who said in 1905 that the aeroplane must always remain a toy and would never fly far. I believe these difficulties will be conquered and then—what a changed world!

To begin with the most important thing: the question before us all is whether we are going to get rid of war or war is going to get rid of us.

Everyone who has struggled with this problem understands that it has a dual nature. We must organize the world in such manner as to have a real international law between nations as we have national law between individuals; and we must back up this law by a real moral sense.

From a photograph made for POPULAR RADIO

WILL IRWIN LISTENS IN

In the radio he sees something infinitely greater than a mere instrument for entertainment, however. He conceives it as a medium for bringing the scattered peoples of the world into contact and eventually into understanding.

Leagues or associations of nations, tribunals of arbitration, Pacific pacts, will serve but little if peoples keep up those old hatreds and suspicions which result mainly from poor acquaintance—if the average German continues to believe that the average Frenchman is a false, immoral little doll, and the average Frenchman believes that the average German is a wallowing human hog.

I remember an instance which points the moral. Three months after the armistice, I traveled down the Rhine with a commission of French officers. In the party was a young lieutenant, member of a family which owned a famous French printing establishment. He had been brought up in the business; art typography was his hobby. Also, he hated Germans. At Mayence (or Mainz) lived Gutenberg, generally credited with the rediscovery of printing for the western world. In the town museum are kept not only his presses, his types and specimens of his early work, but a library of artistic printing which has been accumulating for four centuries. The lieutenant and I, the only members of the party interested in such things, went A. W. O. L. to visit the museum. We were admitted by the curator, a crop-headed little German with a square set to his shoulders, a red scar across his scalp and a barking voice. Every line and tone and gesture proclaimed that he was an ex-officer of the late Imperial army. The Frenchman saluted formally; the German clicked his heels and bowed stiffly. We moved to the collection in an atmosphere of frigid hate, badly veiled with overdone politeness. And so we plunged into Gutenberg and into exchange of views on printing. When, four hours later, we left the Museum, the Frenchman and German shook hands enthusiastically, and both of us visitors had joined the Gutenberg Society! The bond of common intellectual interest is stronger than the bonds of race.

So, in the next generation the average German of Nuremberg, say, may remember, as war clouds the horizon, that French boy of Tours with whom he used to discuss every night his butterfly collection or his stamps or his troubles with his wireless apparatus. And it will not be possible to make him believe with conviction that every Frenchman is an effeminate little rat. And similarly the Frenchman, remembering Hans, the ether-chum of his youth, will not swallow the idea that every German wallows in blood. That is the boy end of it—wireless telegraphy, glory be, is primarily a boy-activity. And because the thoughts of youth are long thoughts it is also the important end. But men too will be speaking nightly with men of similar tastes. "How can I hate a man I know?" said Charles Lamb.

All this, provided we overcome the language barrier. And there comes another fascinating possibility. All my generation, certain enthusiasts have been inventing and trying to implant a universal language. The Esperantists showed how simple a language could be made. Strip it of grammatical irregularities and idioms, construct its vocabulary so far as possible from those roots common to all the European tongues, and you have a language in which any person of average intelligence ought to become proficient in a few weeks. Indeed, people especially gifted in the language faculty have learned a good speaking knowledge of Esperanto in a week. But none of these projects "took hold;" Esperantism remained the tongue of a few enthusiasts. There was lacking a pressing need—the only thing which urges men on to great changes of habit. The need is here.

Who knows but in the days of my grandson every school of standing will be teaching along with the native tongue a tongue universal? And if that comes about—all it will mean for peace and international understanding—we shall owe it solely to the wireless telephone.

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WILL THE AMATEURS BREAK DOWN INTERNATIONAL BOUNDARIES?

These school boys at Haslemere, England, are doing something more than merely rigging up an antenna on an old wind mill; they are laying the foundations for a radio acquaintance with schoolboys in France and Germany and Italy —and perhaps some day in America.

General Electric

There Are No Ether Waves

A New Conception of Radiant Energy That Disposes of Many Present Day Theories

By Dr. Charles P. Steinmetz

THE *author of this article—who is not only a great electrical engineer and the Chief Consulting Engineer of the General Electric Company but also one of the greatest physicists of the world—does not believe in ether waves. Science, he says, has disproved the real existence of any material substance like the ether. In this statement he reflects the most recent scientific conclusions on the subject. Light and radio waves are merely properties of an alternating electromagnetic field of force that extend through space.*

Scientifically this is conclusive. Professional scientists do not need the idea of the ether. They can think better without it. They can think better in terms of an electromagnetic field.

For non-scientific readers this may not be so easy. The idea of a field of force is not easy to grasp. Perhaps it will be necessary for a while, for beginners to retain the understanding of radio effects by the ether hypothesis—to think of light and other radiations as being waves in something, waves like waves in the water.

To science the ether hypothesis is useless. In helping the mind to get a preliminary idea of radio, it may still be of service. Just as it is convenient to keep on thinking of gravitation as a force between two pieces of matter, although the Einstein theory of relativity has shown that gravitation is neither a force nor energy nor a property of matter, but is, apparently, a property of space.—Editor

THE greatest contribution to science of the last ten or fifteen years, in my opinion, is the theory of relativity as worked out by Einstein and his collaborators. It is of vital importance because it revolutionizes our whole conception of nature and space. The theory of relativity concludes that there exists no absolute position or motion, but that these elements are relative.

In other words, if we had only one single body in the universe we could never know whether that body is moving or standing still. If we had two bodies we could never find out whether body A moves and body B stands still, or whether body B moves and body A stands still. Nor could we determine whether they both move. There is no real absolute motion and we can speak of motion as relative only. If we had only one body in other words there would be no reason in speaking of that body as either moving or standing still. The conception of motion comes in only when there is more than one body.

This conclusion is incompatible with the hypothesis of the ether as carrier of light.

If ether fills all space, then there must be absolute position and absolute motion. A body is at rest or is moving relative to the ether, and this would be an absolute motion and would enable us to find out whether the body is standing still in regard to the ether or whether it is moving in regard to the ether, even if no other body existed.

If the theory of relativity is right, therefore, then there can be no such thing as the ether and the ether hypothesis is untenable. It becomes necessary, then, to look into this ether hypothesis to determine how it was evolved and what it means.

The first theory of light which demanded attention was promulgated by Newton. He explained light as a bombardment of minute particles projected at extremely high velocities. If this corpuscular theory of Newton's is right, then two equal beams of light when superimposed, must always combine to a beam of twice the intensity. Experience shows, however, that two equal beams of light, when superimposed, may give a beam of double intensity or they may extinguish each other and give darkness, or they may give anything between these two extremes. This can be explained only by assuming light to be a wave, like an alternating current. Depending on their phase relation the combination of two waves, as two beams of light or two alternating currents, may be anything between the sum and the difference of the two intensities. Thus two alternating currents which are in phase add; if they are out of phase they subtract.

If light is wave motion, there must be something to move, and this hypothetical carrier of the light wave has been called the ether. At this point our troubles begin.

The phenomenon of polarization shows that light is a transverse wave; that is, the ether atoms, or whatever it is that moves in the ether, move at right angles to the light beam, and not in the direction of the beam as is the case with sound waves. In such transverse motion, a vibrating ether atom neither approaches nor recedes from the next ether atom, and the only way in which the vibratory motion of each ether atom can be transmitted to the next one is by forces that act between the ether atoms so as to hold them together in their relative position. That is, transverse waves can exist only in solid bodies. As the velocity of light is extremely high (180,000 miles a second) the forces between the ether atoms, which transmit the vibrations, must be very great.

In other words, the hypothetical ether is a solid with a very high rigidity—infinitely more rigid than the hardest steel.

At the same time the ether must be of extremely great tenuity, since all the cosmic bodies move through it at high velocities without meeting any friction. In the revolution of the earth around the

International

DO WAVEMETERS REALLY MEASURE "ETHER WAVES?"

If, as Dr. Steinmetz maintains, there is no such thing as ether there are obviously no such things as ether waves. Accordingly this machine, instead of recording lengths of ether waves, must be recording some other forms of resonant phenomena which do not rest upon the ether hypothesis.

sun either the ether stands still and the earth moves through the ether at twenty miles a second, or the earth carries a mass of ether with it. In the first case, there should be friction between the mass of the earth and the ether; in the latter case, there would be friction between the ether that is carried along with the earth, and the stationary ether. But in either case, the frictional energy would come from the earth and show astronomically as an increase of the length of the year and increase of the solar distance. And no such evidence of ether friction is observed.

The conception of the ether is one of those hypotheses, which have been made in the attempt to explain some difficulty, but the more it is studied, the more unreasonable and untenable it becomes. It is merely conservatism or lack of courage which has kept science from openly abandoning the ether hypothesis. Belief in an ether is in contradiction to the relativity theory, since this theory shows that there is no absolute position nor motion, but that all positions and motions are relative and equivalent.

Thus the hypothesis of the ether has been finally disproven and abandoned.

There is no such thing as the ether. And light and wireless waves are not wave motions of the ether.

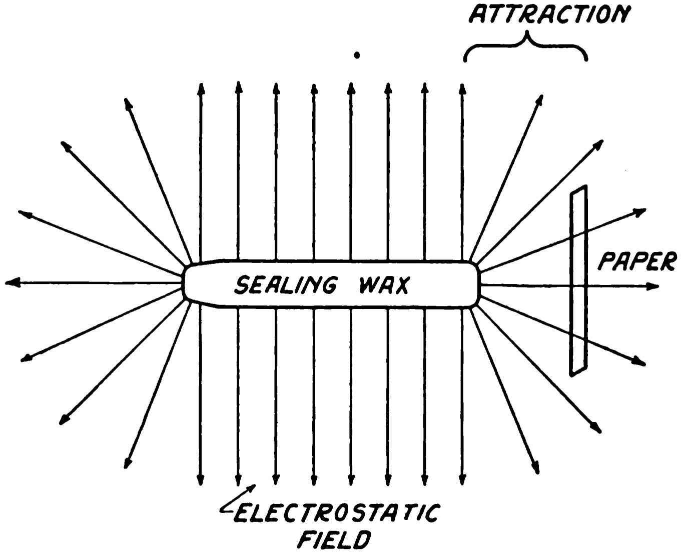
What, then, is the fallacy in the wave theory of light, which has led to the erroneous conception of the ether?

The fact that beams of light can cancel out each other, and can interfere, proves that light is a wave, a periodic phenomenon, just like an alternating current. Thus, the wave theory of light and other radiations stands today just as unshaken as ever. However, when this theory was established the only waves with which people were familiar were the waves in water and sound. Both are wave motions. Waves involving movement of matter. As the only known waves were wave motions, it was natural that the light wave was also considered as a wave motion. This led to the question; what moves in the light wave? And this question led to the hypothesis of the ether, with all its contradictory and illogical attributes. But there is no more reason to assume the light wave to be a wave motion of matter than there is to assume the alternating current wave to be a motion of matter. We know that nothing material is moving in the alternating current, and if the wave theory of light had been propounded after the world had become familiar with electric waves of alternating currents, that is the waves of periodic phenomena (which are not wave motions of matter), the error of considering the light wave as a wave motion would never have been made and the ether theory would never have been propounded.

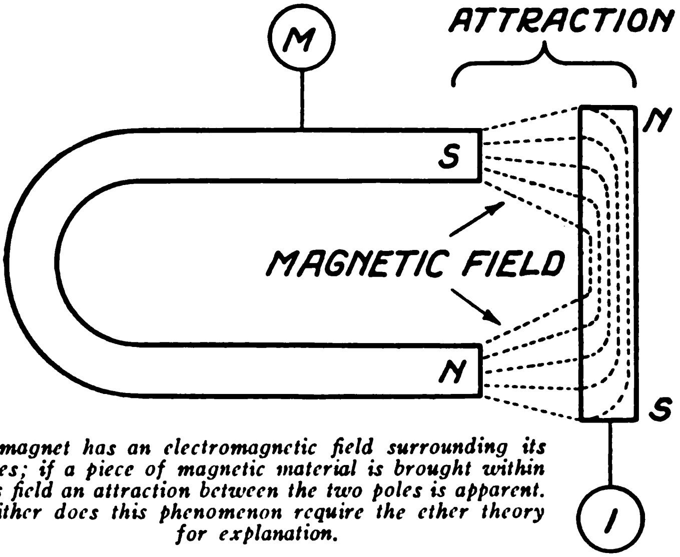
Hence, the logical error, which led to the ether theory, is the assumption that a wave must necessarily be a wave motion. Electrical engineering has dealt with alternating currents and voltage waves; it has calculated their phenomena and applied them industrially, but it has never considered that anything material moves in the alternating current wave and has never felt the need of an ether as the hypothetical carrier of the electric wave. When Maxwell and Hertz proved the identity of the electromagnetic wave and the light wave, the natural conclusion was that the ether is unnecessary also in optics. But curiously enough, we then began to talk about electric waves in the ether and about ether telegraphy. In other words, we dragged the conception of the ether into electrical engineering, where it never had been found necessary before.

But, if the conception of the ether is unnecessary what are we to think of as the mechanism of the light wave and the electromagnetic wave?

Suppose we have a magnet. We say that this magnet surrounds itself by a magnetic field. Faraday has given us a picture representative of the lines of magnetic force. Suppose we bring a piece of iron near this magnet. The iron is attracted or moved. A force is exerted on it. We say that the space surrounding



This diagram illustrates an electrostatic field that is set up around a piece of sealing wax by rubbing it with a bit of cloth, thus attracting such objects as pieces of paper, for example. This phenomenon does not rely upon the ether theory for explanation, states Dr. Steinmetz; it is explained on sounder scientific grounds.



A magnet has an electromagnetic field surrounding its poles; if a piece of magnetic material is brought within this field an attraction between the two poles is apparent. Neither does this phenomenon require the ether theory for explanation.

the magnet is a magnetic field. A field, or field of force, we define as "a condition in space, exerting a force on a body susceptible to this field." Thus a piece of iron being magnetizable—that is, susceptible to a magnetic field—will be acted upon. A field is completely defined and characterized at any point by its intensity and its direction.

To produce a field of force requires energy, and this energy is stored in the space we call the field. Thus we can go further and define the field as "a condition of energy storage in space, exerting a force on a body susceptible to this energy."

The space surrounding a magnet is a magnetic field. There are other kinds of fields of force. For instance, if we electrify a piece of sealing wax by rubbing it, it surrounds itself by a dielectric or electrostatic field, and bodies susceptible to electrostatic forces—as light pieces of paper—are attracted.

So the earth is surrounded by a gravitational field. If a stone falls to the earth, it is due to the stone being in the gravitational field of the earth, and being acted upon by it.

Now suppose that, instead of our permanent magnet with its magnetic field of force, we have a bundle of soft iron wires, surrounded by a coil of insulated copper wire, and that we send a constant direct current through this coil. We then have an electromagnet, and the space surrounding the magnet is a magnetic field. If now we increase the electric current, the magnetic field increases; if we decrease the current, the field decreases; if we reverse the current, the field reverses. If we send an alternating current through the coil the magnetic field alternates, that is, the field becomes a periodic phenomenon or a wave: an alternating magnetic field wave.

Similarly, by connecting an insulated conductor to a source of voltage we produce around it an electrostatic or dielectric field; a constant field, if the voltage is constant, an alternating dielectric field, (that is, a periodic or wave phenomenon), if we use an alternating voltage.

Magnetic and electrostatic fields are usually combined, since where there is a current producing a magnetic field there is also a voltage producing an electrostatic field. Thus the space surrounding a wire that carries an electric current is an electromagnetic field, that is, a combination of a magnetic field and an electrostatic field. If the current and voltage are constant, the electromagnetic field is constant. If the current and voltage alternate, the electromagnetic field alternates; that is, it is a periodic field or an electromagnetic wave.

Maxwell deduced mathematically, and Hertz demonstrated experimentally that the alternating electromagnetic field (the electromagnetic wave), has the same speed of propagation as a light wave. It has been shown that the electromagnetic wave and the polarized light wave are identical in all their properties. Hence light is an electromagnetic wave.

Electrophysics has been successfully developed to its present high state, has dealt with alternating currents, voltages and electromagnetic fields, without ever requiring a medium such as the ether.

The conception of the field of force, or as we should say more correctly the field of energy, thus takes the place of the conception of the ether. The beam of light, the wireless wave, any electromagnetic wave is a periodic alternation of the electromagnetic energy field in space. Differences between light and other waves are merely those due to differences of frequency. Thus the electromagnetic field of the 60-cycle transmission line has a wavelength of

$$\frac{3 \times 10^{10}}{60} \text{ cm} = 5000$$

kilometers. The field is limited to the space between the conductors and their immediate surroundings. This is extremely small compared with the wavelength. Under these conditions, the part of the electromagnetic energy which is radiated into space is extremely small —so small that it can be neglected. In radio communication we use wavelengths of 15,000 to 200 meters and less; that is, frequencies of 20,000 to 1½ million cycles and more. The circuit is arranged to give the electromagnetic field the greatest possible extent, as it is the field which carries the message. Then a large part, even a major part, of the energy of the electromagnetic field is radiated. The frequency of the light wave is much greater still, 600 millions of millions of cycles. The wavelength, 50 microcentimetres, is a very tiny part of the extent of the field. Therefore practically all of the energy of the field is radiated; none is returned to the radiator.

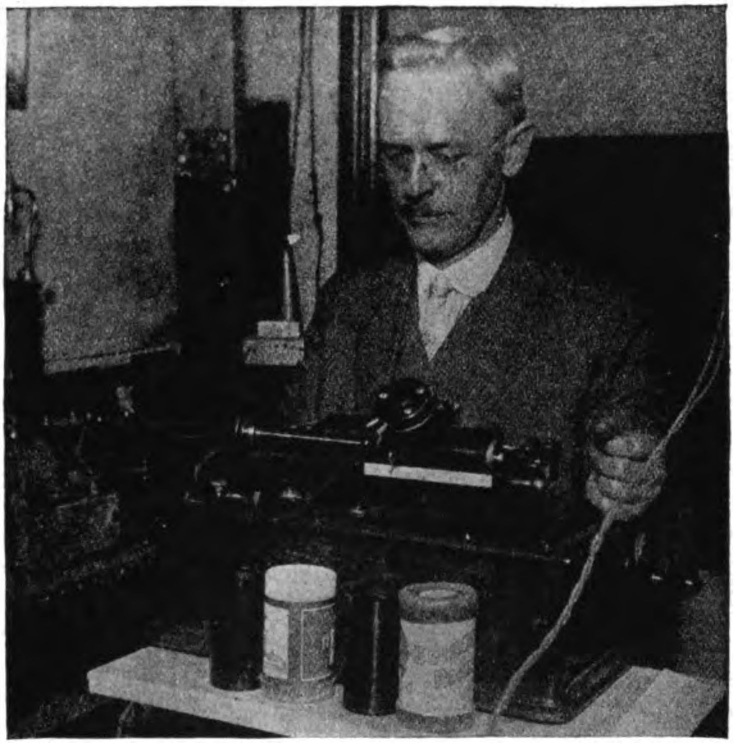
Our lack of familiarity with the conception of an energy field in space, and our familiarity with the conception of matter as the carrier of energy, may lead to the questions: What is the carrier of the energy of the field of space? Would not the ether be needed as a carrier of the field energy, just as on the older theory it was needed as a carrier of the hypothetical wave motion of matter?

These questions are due to a mental error. Familiarity reverses the relation between primary and secondary conceptions.

All that we know of the world is derived from our senses. They are the only real facts; everything else is conclusioned from them. All sense perceptions are due to energy; they are exclusively energy effects. In other words, energy is the only real existing entity. It is the primary conception, a conception which exists for us only because our senses respond to it. All other conceptions are secondary conclusions, derived from the energy perceptions of our senses. Thus space and time and motion and matter are secondary conceptions with which our mind clothes the events of nature.

Obviously, then, by carrying the explanation of light and electromagnetic waves back to the energy field—to energy storage in space—to the electromagnetic field, we have carried it back as far as possible. We have carried it back to the fundamental conceptions of the human mind; the perceptions of the senses.

¶ *In the next issue—August—will appear the article by Dr. E. E. Free, "How the Sun Helps Wireless," which has been held over from this number in order to include some new and valuable material that is being prepared epecially for* Popular Radio.



From a photograph made in 1915 by Samuel Cohen

A RADIO AMATEUR WHO BALKED THE GERMANS SINGLE-HANDED

One of the most valuable services ever rendered by a radio operator in this country was performed by Charles E. Apgar, who made phonograph records of the mysterious code messages sent out by the Telefunken station—and furnished evidence that compelled the Government to take it over.

The Secret Service *of* the Air

How the police are beginning to use radio in running down crooks was told by Fred C. Kelly in the June number of this magazine. In this article the author (who prefers to remain anonymous) describes how the crooks themselves are using wireless—and how they have been caught at their own game.

By ONE OF THEM

A TOURIST, clad in white, perched upon the edge of the dock at Nassau and dangled a fishing line through the glass-clear water. Near at hand—within earshot in fact—a schooner much in need of a coat of paint was moored to the dock among other even more weather-beaten craft. With West Indian disregard for time, black stevedores were loading cases upon the schooner, as they had been doing for days past; likewise for days past the tourist had been fishing at the same spot. But his eyes, shaded by the broad Panama hat, watched every movement on the dock or schooner. And when the final case had been placed aboard the schooner, her crew started to strip the covers from her furled sails.

The tourist rose, strolled up the street and ten minutes later from the big wireless towers a message was speeding through the air. It was an innocent enough message, evidently of no great importance. It read:

"Hendryx, Washington. Helena leaving. Try meet her on arrival. She has considerable baggage."

The secret service of the air was at work. It was doing its bit to stop the influx of contraband liquor from the Bahamas. But even the secret service of the air is not always infallible.

* * *

A few days later, upon a smooth sea, with Martha's Vineyard just out of sight below the horizon, a speedy looking schooner much in need of a coat of paint lay hove-to, rolling gently to the Atlantic swell, a blue triangular flag at her main topmast head.

Presently, in the direction of the land, a tiny white speck appeared which developed into a rushing power boat, her brass work gleaming in the sun and her mahogany cabin glistening with varnish. At the boat's wheel was a uniformed officer and another yachtsman; at the summit of the craft's single mast there streamed a triangle of blue.

International

EAVESDROPPING BY RADIO

When the San Francisco police raided a local bucket shop they found this miniature radio apparatus for receiving stock tips transmitted by a confederate in a broker's office that had wire communications with the N. Y. Stock Exchange.

Upon the schooner's deck a bull-necked man gazed at the oncoming yacht through his glasses.

"That's him," he remarked and gave an order to a mulatto standing near. A moment later, a tiny ball rose upward to the schooner's trucks and broke out into a square of white bunting. Immediately upon the power boat's mast there appeared a red triangle beneath the blue. Fifteen minutes later, the yacht was motionless fifty yards from the schooner and a rowboat was dancing towards her.

A few nights later a small schooner, much in need of a coat of paint, was headed towards the inner harbor of New York under her rickety gasolene kicker. A police boat fell in behind the slowly chugging little schooner, trailing in her wake until she at last turned up the East River and dropped anchor off a recreation pier under the shadow of Queensboro bridge.

But on that silent run up the harbor the secret service of the air had not been idle. Lurking about the pier, crowded in the shadows, were armed men. The *Helena* would indeed be met at the dock and her baggage well looked after! And there were others there too. Motor cars and trucks were parked near the dock, as if awaiting loads; most of them had their engines running. The waiting officials and police figuratively patted themselves on their backs. There had been no hitch in their plans; the schooner was in the stream; the trucks were awaiting her cargo.

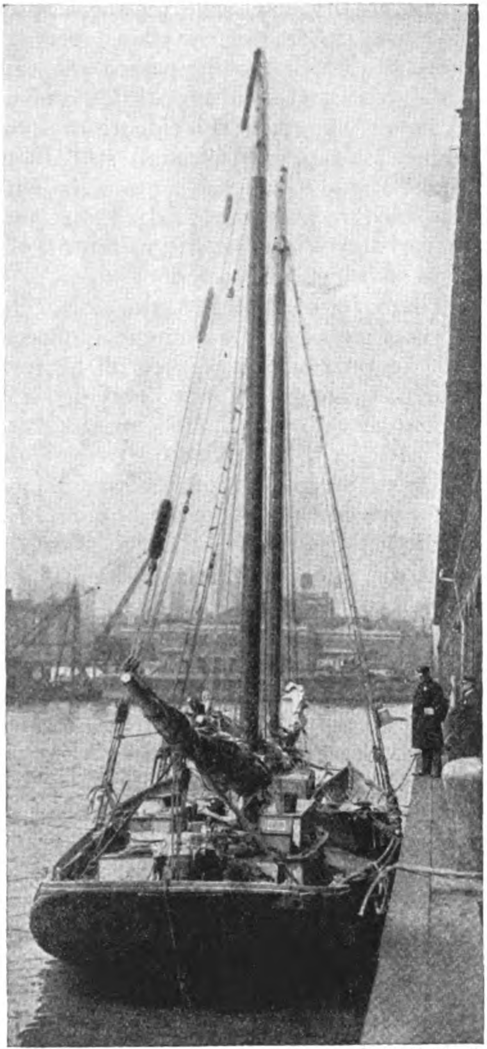
Presently, from the river came a sharp whistle—three short blasts and a long one. From a waiting car came the reply. A moment later, the staccato exhaust of the craft's motor echoed over the river and the schooner came slowly alongside the dock. Scarcely were her hawsers made fast when the hidden men swarmed over her bulwarks like old-time buccaneers boarding a prize. A few seamen exchanged blows with the raiders; a bull-necked man swore a bit, and all was over. An hour later the heavily loaded motor trucks were rumbling through the streets with armed men beside the chauffeurs and a patrol wagon was carrying a bull-necked man with several of his fellows to a police station.

The following morning, however, the bull-necked man and his fellows walked forth from their enforced quarters of the previous night. Disgruntled prohibition officers glared after them as they tumbled over the bulwarks of their schooner, cast off the hawsers and with spluttering motor headed down the river.

Within the cases, boxes and kegs that had been seized there was not a drop of liquor. Nothing but plain sea water and unfermented cane juice!

But in another part of the city a few men, just returned from a cruise in a fast power boat, sat in a luxuriously furnished apartment and joked as they read the accounts of the schooner's seizure. Safe from prying eyes, they had stored enough of the real liquor to keep them supplied with luxuries for many weeks.

On this occasion the secret service of the air had lost, but such are ever the fortunes of war. Constantly, day and night, week after week and month after month, a battle of wits is being waged between officers of the law and law-breakers—and both sides are using the secret service of the air.



Pacific & Atlantic

CAPTURED ON A TIP VIA WIRELESS

Not all schooners seized by the excise officers carry liquor; sometimes the rum-running plan to let the authorities get false tips by radio and run down a decoy vessel that carries no contraband at all!

Few people realize what an important part radio has played in apprehending criminals; few realize what a tremendous part it played in the war; fewer still realize its possibilities and its limitations. And, although it is the easiest of means for transmitting secret messages, at the same time it is the most difficult means for keeping anything secret. A message hurled through space by wireless is everyone's property and the code has never yet been invented which cannot be decoded. Moreover, a law-breaker who hears a code message or even one which savors of a hidden meaning, at once is on the alert. Guilty consciences make keen wits and suspicions are at once aroused. The simplest and apparently the most innocent message may carry a hidden meaning which no one could ever suspect.

During the war, code messages often gave way to apparently plain, everyday messages which readily passed the censors. Now and then some little peculiarity, some chance or coincidence or some "hunch" aroused suspicions; still, thousands of radio and cable messages with concealed meanings passed in and out. Remarkably clever were many of the ways in which this was done, too.

There, for example, was the case of the German messages, a meaningless, musical hum or buzz which puzzled all hearers, which meant absolutely nothing and which caused endless annoyance in 1914 and early in 1915. With the tremendous power of the great Nauen station behind it, the musical note, like the buzzing of a titanic bumblebee, sped through space.

At the same time a somewhat similar phenomenon was observed by radio operators in connection with the large radio transmitting station of the Atlantic Communication Company (generally known as the "Telefunken Company"), located at Sayville, Long Island. In the words of L. R. Krumm, who at the time was Chief Radio Inspector of the Bureau of Navigation in New York, his staff noticed that shortly after the declaration of war in August 1914, "Sayville station was sending and receiving a considerable number of extraneous messages not considered part of the regular traffic, which was supposed to be in plain English." The mystery was brought to the attention of William J. Flynn, Chief of the U. S. Secret Service, but the strange signals and buzzes could not be deciphered. Was the Sayville station sending information to the Germans? The matter looked serious.

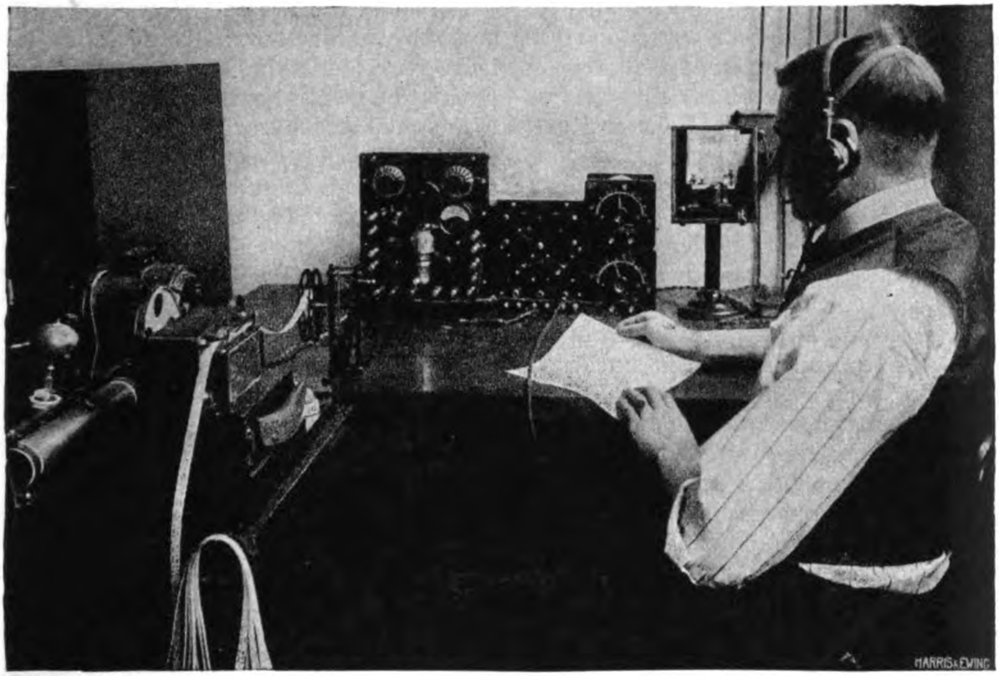
But Uncle Sam's secret service of the air were not the only ones to note the Sayville signals. Over in Westfield, New Jersey, a keen-witted radio amateur, Charles E. Apgar, had also been studying them on his own account. Every night at eleven o'clock he had noted that the Sayville Station had called POZ—which was the great radio station in Nauen, Germany. Upon establishing contact, the Sayville Station proceeded to communicate with an incredible speed—so rapid as to make the messages unintelligible.

Mr. Apgar got an idea. He had been experimenting successfully as far back as 1913 in recording radio signals on wax phonograph records. To do this he had developed an amplifying apparatus of a highly ingenious nature that he called an "ampliphone"—an apparatus that enabled him to read radio messages at a distance of 600 feet from his house. Why not make phonograph records of the Sayville signals and study them at his leisure?

He did so. But no sooner had he gotten started on this self-imposed task, however, when he received a summons from Mr. Krumm, who introduced him to William J. Flynn. The next day Mr. Apgar was pursuing his investigations for the U. S. Secret Service. On June 7, 1915, he picked up his first phonographic record of the Sayville radio signals. For two weeks he labored, during which he piled up scores of wax cylinders. This canned evidence was then delivered to the government authorities.

Perhaps in poring over these transcriptions the motor of the phonograph ran down, and as the wax cylinders revolved more slowly the "buzz" became disintegrated and resolved itself into distinguishable code signals. At any rate, Mr. Apgar's wax records revealed vital information — and the Sayville station was promptly taken over by Uncle Sam. And it was a radio amateur who did it—admittedly one of the most valuable services rendered by an individual during the war.

Both the Germans and the Allies used innumerable methods for transmitting secret messages; many of the most effective of these did not die with the cessation of hostilities. Some of them were adopted by law-breakers as well as by law-abiding persons when they wished to communicate without letting others know what was being said. It would surprise the average person to know how many and how simple are the available means



© Harris & Ewing

IT IS EASY TO SEND SECRET CODE MESSAGES BY RADIO ON TAPE MACHINES

The dot-and-dash system, by which letters and figures are indicated by transmitting apparatus that punctures paper strips, may be readily manipulated to convey undecipherable meanings to those who are not in the secret.

of sending secret messages. Despite popular ideas, codes or cryptograms are neither the most commonly used nor the safest. Of course, any message with a hidden meaning is a code message; the fact that such codes are not recognizable as codes make them the most difficult to detect or to decipher.

Who, for example, would suspect anything out of the ordinary in a radiogram stating that a cargo of sugar had been shipped and that the bills of lading were going forward by hand? And who would guess that another message announcing the birth of a child and stating it had been christened Mercedes would have any hidden meaning? Such messages passed the censors without question yet by a coincidence which, if used in fiction, would be scoffed at as impossible, these innocent-appearing messages led to the apprehension of the most dangerous and long-sought criminals.

Wholly by chance, a quiet man whose secret mission was unknown outside of a scant half dozen officials, happened to be a passenger upon the very ship by which this sugar was supposed to be forwarded. By an even more remote coincidence, he saw the innocent appearing message. Instantly his suspicions were aroused, for he had watched the steamer's cargo going aboard and he knew there was no such shipment. The rest was easy. "Sugar" meant important information; the "bills of lading" meant documents and the message from a fond and proud parent announcing the "arrival of a daughter" was nothing more or less than a tip as to when the bearer of the letters sailed and her name.

That time the secret service of the air scored against the enemy.

While such a method of communication is perhaps the safest and most secretive, it is not a simple nor a satisfactory way to carry on a secret correspondence in cases when messages must be frequently interchanged. Elaborate codes of double meanings must be prearranged and the messages must present a natural appearance with apparent sense to them. To invent messages which appear natural and which are composed of words with double significance is no child's play. For a brief time they may pass unquestioned; but sooner or later some lynx-eyed man may wonder why certain unusual words recur so frequently and an investigation will result—usually with unfortunate results to the conspirators. It is practically impossible to prevent messages by radio from reaching their destination or to prevent secret messages from being received by those for whom they are not intended. Anyone can receive; only a house-to-house daily search could put the lid effectively upon receiving by radio. With indoor and loop aerials the enemy is perfectly safe; he can hear every message that speeds through the ether. During the war, all amateur and private wireless stations were closed. Because the government did not wish its messages to be heard? Not a bit of it. Our officials never for a moment deluded themselves with the idea that they could prevent messages from being heard. But to prevent messages from being sent.

Uncle Sam could censor, hold up, destroy or forbid messages by telegraph, cable or mail—but not by radio. If any radio messages were permitted to go out, all who listened could hear them; there was no censorship, no control possible except by closing all sending stations—and even that was impossible. If a spy or a criminal wanted to send a radio message he could send it and did send it. Not on a large scale to be sure. But there was nothing to prevent him from setting up a station, getting his message or information off and hastily vacating the vicinity. And there was many a warning sent through the ether in just this way. But during time of war it is far easier to control the air than in times of peace.

The means of getting secret radio messages through without detection are almost unlimited; a force of trained men constantly at work would be necessary to keep pace with the schemes put into practice by men, who, if they turned their brains and inventive ability to legitimate channels, would make fortunes. It is said, (although I am not sure that it was ever demonstrated), that the Germans devised a method of sending out radio waves of such incredibly high frequency that no ordinary set could receive them; that even after being reduced by detectors they were still too rapid to produce a vibration in the receiver that was decipherable; only by means of special apparatus designed for their reception could the code be caught.

But the majority of devices for carrying on an aerial secret conversation are far simpler and less spectacular than anything of that sort. Specially designed typewriters, in which the type bars do not carry the letters corresponding to those on the keyboard can be used to produce messages which are almost beyond the possibility of decoding, yet the other party to the scheme, merely by typing off the message on a machine in which the letters are reversed, can translate the hodgepodge of letters into a legible message.

On one occasion while in Europe I received a radio code message which could not be decoded. At least, all the experts in London, including the naval and military intelligence officers, the Admiralty experts and the inventors of innumerable codes, could make nothing of it. Yet it was the simplest code in the world—once you knew the key.

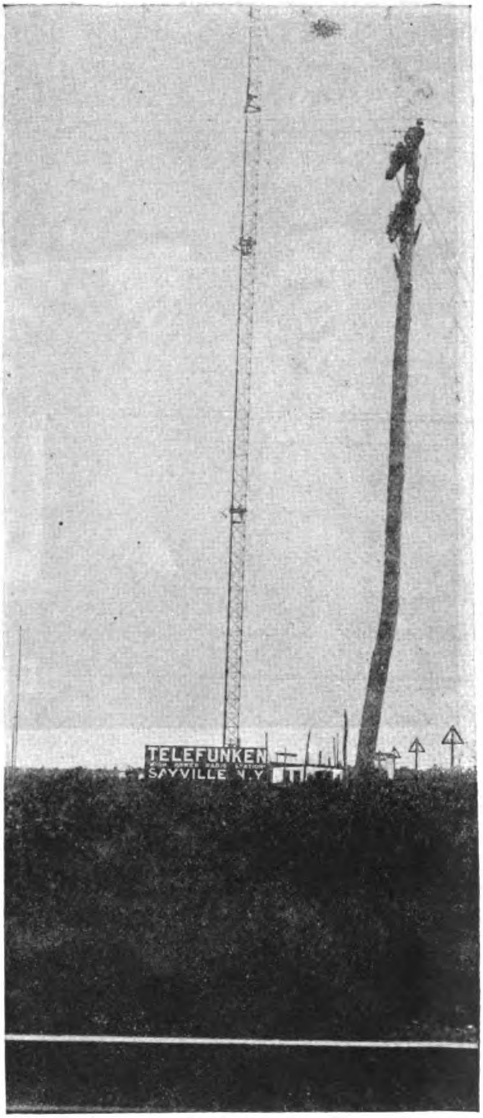
I had left word with a friend to use a certain well known commercial code when communicating with me. The first message I received was not in this code and I could not decipher it. In vain I took it to every office of the published commercial codes; every expert shook his head and declared it was not like anything he had ever seen. Meanwhile my friend was on the high seas out of reach and for many months the message remained a curiosity, one of the few messages which had baffled British and American officials alike.

When I at last returned and met the sender my first question was, "What code did you use with that message?"

He replied that he had used the one I had designated and to prove his statement he produced the book he had used. The book was a maritime edition of the code and the words my friend had used were the combinations of letters representing signal flags to be flown when sending signals corresponding to the commercial code words. In other words, my innocent friend had used a code within a code which could only have been deciphered by running up the corresponding flags and translating the code from them. Here, once more, mere chance had played an important part and I wondered that some one had not stumbled on the idea before.

Another means of using the code is to use a specially prepared and arranged tape-puncturing machine which will produce a special tape for sending. When the dot and dash messages are sent from the big stations the operator does not tap off the dots and dashes on a key, as does the operator in a country railway station. Instead, the message received from the sender is copied on a typewriter-like machine which bears groups of dots corresponding to letters upon its type bars. When a letter is struck, a tape is perforated with dots. Then this perforated tape is run through a sending machine that is provided with metal fingers which make contacts through the perforations in the tape and automatically send the message vibrating through the ether at far greater speed than any human hand and brain could tap it off on a key. On the ordinary tape, two dots, one above and one below a central line, signify a code dot while one dot above and one below but slightly out of line vertically mean a dash.

But there is nothing to prevent a person so disposed from altering this conventional arrangement. Suppose it were prearranged that one dot directly above another meant a dash, that two dots out of line meant a dot and that two dots close together meant two dashes or anything else. Such a tape would produce messages which, when recorded on the receiving machine, would present an ir-



International

CLOSED BY THE "SECRET SERVICE OF THE AIR"

The famous transmitting tower at Sayville that once held mysterious radio communications with Nauen, Germany, every midnight—until its mystery was solved by a peer of Sherlock Holmes.

International

THE POLICE OF PARIS USE THE RADIO ON THEIR MOTOR VANS

On May 1st—the day observed by the radical elements—the Prefect of Police of Paris experimented with radio-equipped motor vehicles that enabled the authorities scattered at different points about the city to keep in communication not only with headquarters but also with officers in a police airplane, as an aid in directing the crowds that participated in the May Day demonstrations. The Prefect is the portly gentleman in the derby hat at the right of the picture.

regular or serrated line which at first glance would appear to be an ordinary message, but which would be meaningless to those not in the secret.

Endless variations are possible in this way and have proved one of the greatest puzzles to the secret service of the air. Indeed, the dot and dash codes have always provided a most easy and simple means of secret communication. A prisoner tapping out the dots and dashes in his cell, may readily talk with his fellows and this is a well known and widely practiced means of communication among convicts in prisons.

If a person desires to communicate with another by conversing over a radio 'phone it may be done and is being done in such a way that the most secret matters are spoken of freely. It is only necessary to choose the time, the hour when the big broadcasting stations are sending out their nightly programs, and by using waves of a different length few will hear what is being said. Nearly every one will be tuned to the 360 meter waves and attention will be devoted to the music, songs or baseball returns. Even if some amateur or beginner hears the conversation no heed will be given to it—there are far too many more interesting things in the air for that. Sometimes the very frankness of such conversations is their greatest safeguard. If there is nothing suspicious about two people talking, suspicions will not be aroused, and it is just as easy to have a prearranged code of double meanings for spoken words and sentences, for questions and answers, for casual remarks, for numbers and names as for written words. No one knows or can even guess how much plans for hold-ups, burglaries, rum running and other dark deeds may be transmitted nightly by radio.

Next time you are listening to a broadcasting station, tune your set to shorter waves and see how many people you hear talking. If you have never tried it you will be surprised; while you may not hear a word of interest the chances are that something you hear—if you knew its real import—would be vastly interesting to a small army of guardians of the law. Or again, you may hear a conversation which seems pure jargon, a meaningless hodge-podge of numbers, names and words. In that case you may be sure that a secret message is being given.

Radio has been a means of enjoyment to thousands; it has spread like wild-fire through the land. But there was never a crook yet—a really dangerous crook—who was not up to the minute in availing himself of the latest inventions as a means to defeat the law. And radio has been and is a boon to law-breakers as well as to peaceful and law abiding citizens. No wonder it is a difficult undertaking the government has set itself to enforce the prohibition laws. With radio linking boats at sea with shore, warnings and any other information may be sent back and forth between the smugglers' craft and confederates ashore and the secret service of the air cannot prevent it.

Not long ago, a certain man was listening at his set, tuning his instrument to pick up any messages which might throw light upon a plot which, he was led to believe, had been largely carried on by radio. Scattered in various places, there were probably fifty more of his kind doing the same thing.

Night after night they had been doing this, one man constantly at the receivers; yet nothing had been heard which they could lay hands upon.

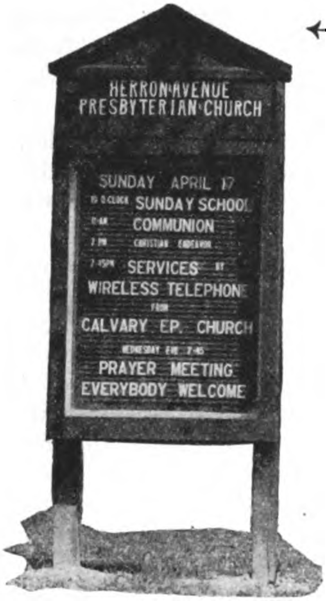
Nothing? Yes, there had been something. Over and over again, a voice had been heard making commonplace remarks; at times mentioning names and numbers. There was nothing suspicious about his voice—but he was apparently talking to himself!

Of course his words were taken down and hours were spent poring over them in attempts to decipher his conversations. But to no avail.

Then, by one of those strange chances, the puzzle was solved. One of the secret listeners-in grew weary of the fellow's one-sided chatter. He breathed a sigh, stretched his cramped limbs and, as he did so, one arm came into contact with a desk telephone near at hand. Instantly, the man was all attention, for where only one voice had been heard before, now there were two! It was no longer a one-sided conversation; a man and a woman were talking!

To the layman the phenomenon would have seemed incomprehensible, but it was simple. The woman, having no sending set, was talking over an ordinary telephone to the man who, listening to her words with ordinary telephone receivers and was talking to her over his radiophone, while she was receiving his words on her receiving set. Only by the chance touch of the listener's arm was the puzzle solved when, through the capacity effect of the human body, the woman's words were made audible over the wireless set. And the joke was on the men with their loop aerials. The mysterious speaker was but a law-abiding citizen; the woman was his fiancée and the mysterious numerals' names and words all referred to plans for the approaching wedding.

Never again would the operators be caught napping if another one-sided conversation came to their ears. They expressed their appreciation of the joke in the form of a wedding gift to the couple who so unconsciously had caused them so many sleepless nights. It was a silver goat bearing the inscription "You got ours." .It was accompanied by a card on which was written: *"With the best wishes of the Secret Service of the Air."*



The first church in the world to conduct a service by wireless is the Herron Avenue Presbyterian Church in Pittsburgh, which inaugurated the plan early in 1921.

Is *the* Radio Hurting or Helping the Church?

The Larger Significance of the Introduction of Wireless Apparatus in the Conduct of Religious Services, and Its Effect upon the Church-Goer and upon the Church Itself

By HOMER CROY

SIX or eight farmers were gathered in an old-fashioned "parlor" on a Sunday morning. The room which had been kept in darkened seclusion for so long was now open, and on formal furniture the people sat, all in intent listening attitudes. And yet not one of them was speaking. Abruptly there was a creaking of chairs, a movement, and the sons of toil knelt. After a few moments they arose, once more to resume their stiff, correct positions. After a time they filed out and climbing in their buggies and cars drove away. They had been to "radio church" in the country. The services had been conducted from the center table.

That is one of the new and astonishing developments of the radio telephone. In rural districts church services are now being conducted by its aid. There had been no preacher, no pulpit—nothing but a few wires stretched from the roof of the house to the ridgepole of the barn and the box on the center table. But they had observed the Bible quite as much as if they had knelt in a cathedral, as the Bible says, "For where two or three are gathered together in my name, there am I in the midst of them."

One of the farmers has a receiving set and on Sunday mornings hitches it on to church services and his neighbors who are not so fortunate come in. It is all there; the complete service; the singing, the sermon—all save one thing and that has to do with a basket. Tell it not in Gath, but it may be that some of them gather a little more cheerfully when they know that at the end of the service two or three solemn looking men are not going to pass down the aisle with large and yawning plates in their hands.

In Wellsburg, West Virginia, as an example, church services are given to the farmers without the people leaving home. In this neighborhood is a group which, until last year, had a small country church which it attended, but finally the church was closed. Now one of the farmers has a receiving set and on Sunday mornings turns the party line into the telephone; his neighbors who had once attended church now take down their receivers and without leaving their homes participate in the church services. Thus is it being done in many sections of the country—and one of the surprising things about it is that it is so impressive that the people kneel and pray.

The radio church is growing at an amazing rate. At first the churches were slow to take it up, as it did not seem compatible with their beliefs that religion could be communicated without contact, but now there is a rush for it. The Church of the Covenant in Washington, D. C., has its own broadcasting station—the first church in the United States to attempt such an experiment.

With the first inauguration of broadcasting, clergymen were called in to deliver brief addresses over the radio, to make announcements. This they would do by coming to the sending room of the broadcasting plant and there send out their messages. To the Calvary Episcopal Church of Pittsburgh belongs the honor of being the first church to send out its entire service by radio. Its clergyman had gone to the sending station, made addresses and the choir had gone. So successful were the experiments that the Calvary Church decided to try the experiment of broadcasting its entire service. As a result a microphone was installed in front of the preacher, another in front of the choir and a third in the rear of the church to pick up any stray sounds. The service was heard by all those who cared to listen in and was an instant success. The first time a complete service was sent into the air was January 2nd, 1921. The church itself was seven miles from the sending station, but the service was clear and distinct.

At about this time the Herron Avenue Presbyterian Church of Pittsburgh found itself without a pastor. It appealed to the board for a minister but was unable to be supplied with one. And then an

Westinghouse

THE RADIO CHOIR—THAT IS REPLACING THE OLD CHURCH CHOIR

It is not inconceivable that many of the small and inexperienced village quartettes will eventually be replaced by large aggregations of great singers whose music will be broadcasted to services conducted over wide areas.

Westinghouse

THE CHURCH SERVICE COMES TO GRANDMA

No longer need the shut-in be deprived of the privilege of listening to the country's best preachers. The radio is beginning to bring his voice even into the remote rural districts.

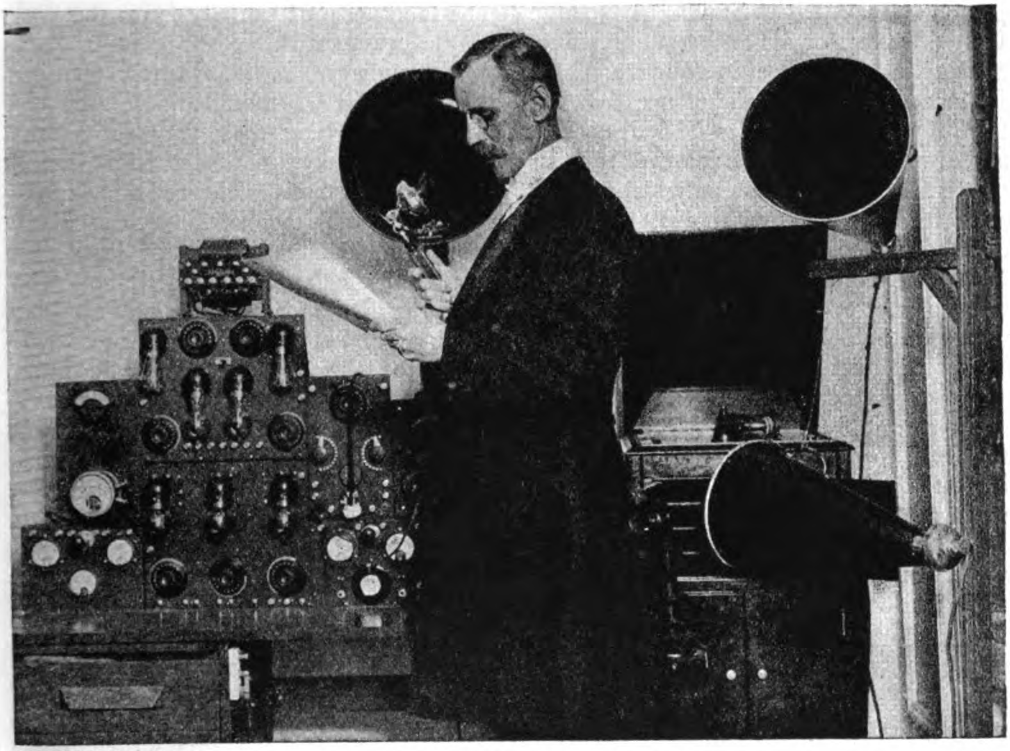
idea came to one of the members of the board of trustees.

"Why can't we hook up to this new thing called the radio telephone and get our service that way?"

No one could answer him because no one knew anything about it; and moreover there was no one they could go to for information, as the experiment had never been tried. They were breaking new land; virgin soil. How could it be done? What about wires? Would people go to church when there wasn't a minister in sight? The idea was top-heavy with questions.

The experiment was tried. An amplifying horn was placed in the pulpit and a loop aerial set up beside it; and then with fears and doubts they awaited Sunday morning. Would the people come? Would they demand a living personality? That was what they had been told. Sunday morning arrived; the people came; the instrument was tuned up—and the service was as clear and distinct as it was to the people in the "parent" church several miles away. Even the coughing of the members of the congregation could be heard! The service moved along until the collection was announced—and two sprightly ushers bounced out into the middle of the aisle. There was nothing lacking except a preacher and a choir.

The service was a success, but the board was afraid that for the first Sunday the church had drawn merely a curiosity audience. But the next Sunday there were just as many people as on the first occasion. The congregation began to grow and soon there were as many people in the audience as when there had



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HOW LARGE IS HIS SUNDAY AUDIENCE?

The average church attendance is small; even in the large city churches it is considerably smaller than the average theater audience. But the preacher who talks by radio may reach tens of thousands.

been a pastor in the pulpit. In fact, in some respects the service was better, as the sending church was larger, had a better preacher and a better choir. The "pastorless" church was getting a higher class service than it would if it had to depend on itself.

The practice was taken up by other churches until now it is known in several states.

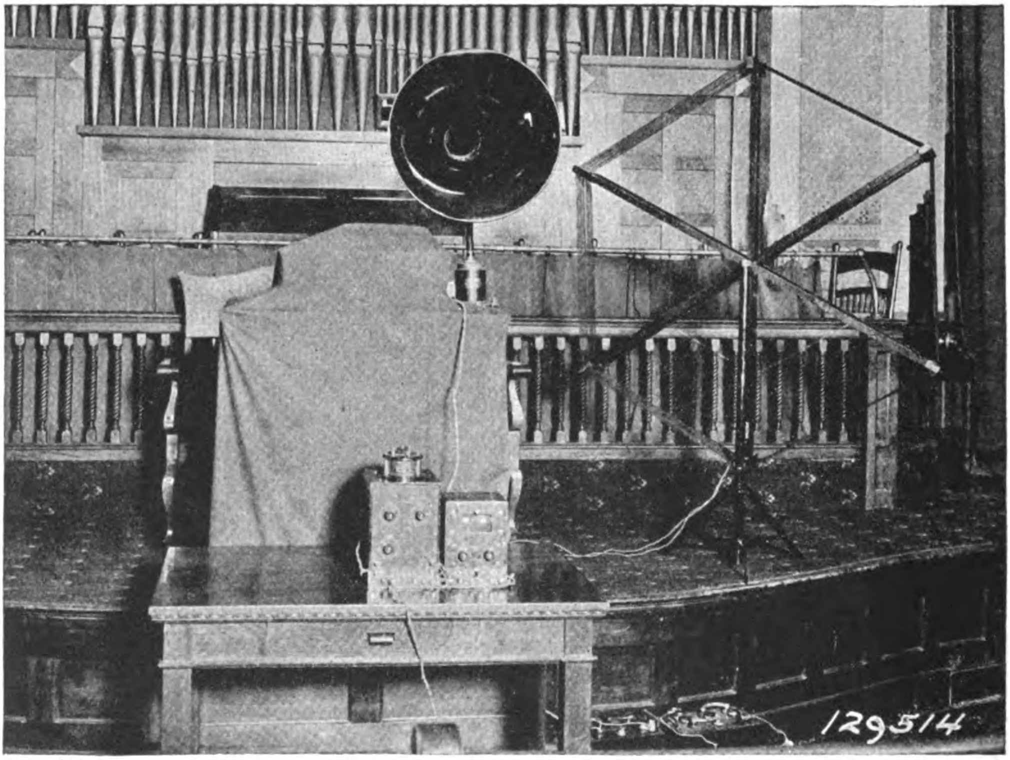
January 2nd, 1921, marks, probably, one of the biggest changes that has ever come into the church. It means the centralizing of the church; the doing away with so many conflicting and needless creeds; so much useless competition and so many petty jealousies which for so long have been a millstone around the neck of the church. Church services will be shortened; much of the verbal underbrush will be cleared out, for sermons that go over the radio will have to say something. They will have to be more than an impressive collection of words. They will have to carry a message and get it over simply and directly.

The radio will mark the disappearance of numbers of small struggling churches and the centralizing of services in a few of the larger ones. Instead of there being thousands of small churches there will be a few large, flourishing ones with exceptional, outstanding pastors. Two or three will suffice for a city the size of Detroit. All those who must stick to one denomination will tune in with the belief that appeals to them most strongly, but ultimately the preacher with the message will be the one that will attract the people. In fact—and be it understood that this is only in the realm of speculation—one exceptional and outstanding preacher may each Sunday have the United States for his congregation. Billy Sunday at his home in Winona Lake, Indiana, may have an audience that extends from New York to San Francisco, and from Canada to Mexico and, for that matter, lap over. He may deliver his sermon from his own home, but it is more probable that he will go to some church where there is a choir and the thrill of a crowd. And no doubt somewhere in the offing will be Homer Rodeheaver with his trombone.

A new audience will be added to the church: cripples, shut-ins, and mothers too tired to go. Cripples who have not been to church in years will have the word of God brought to them. Trained choirs will sing, great pipe organs play and Farmer Jones sitting in his rocking-chair in Boone Stop, Missouri, will hear. The tabernacle of the city is on the way to the cross-roads.

The audience, in the era now opening upon us, will be unlimited. Passengers on liners plowing their way across the ocean will gather in the social hall and listen to sermons delivered on land; people speeding across the continent in trains will participate in the services; passengers in airplanes will listen above the chugging of the machinery, sailors in battleships, and men in submarines will pause for the sermon; men who must work in coal mines on Sundays will hear, and lonely sheep herders will erect their aerials and bow their heads in worship. People in the air, in the water and in the lonely places of the earth will stop to listen. Such an audience is staggering to the imagination, but it is coming.

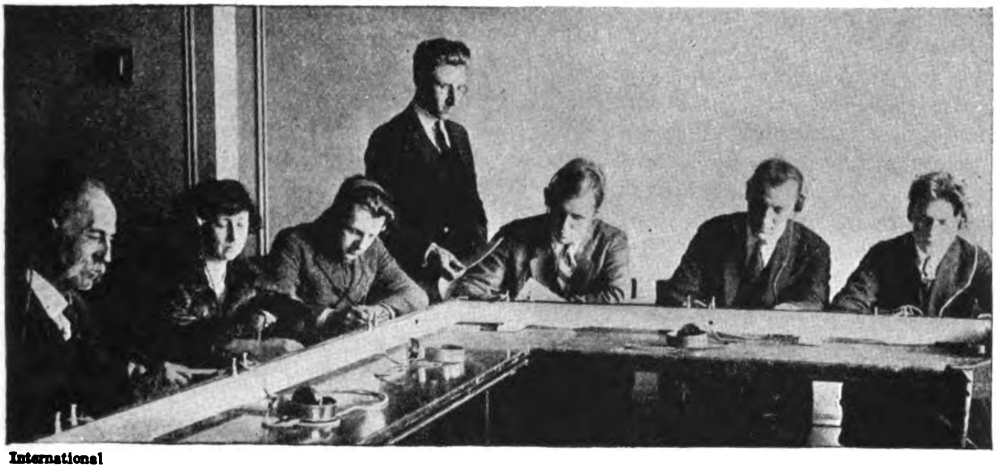
And soon.



Westinghouse

"THEIR PASTOR'S VOICE"——

—but the pastor himself was miles away, preaching by radio not only to his own flock but to other congregations as well. This loud speaker and loop aerial were installed in the Herron Avenue Presbyterian Church in Pittsburgh.



International

CANDIDATES BEING EXAMINED FOR AMATEUR RADIO LICENSES
Licenses are required for transmitting only. To qualify, the candidate must demonstrate his or her capacity to receive and send ten words a minute in the code.

How *to* Learn *the* Code

Sooner or Later Every Owner of a Receiving Set Wants to Enter the Inner Circle of the Ether by Reading the Morse Signals—and the Genuine Radio Fan Learns Them. This Article Is Written by One Who Did—

PAUL McGINNIS

THE student of radio code grows impatient with his perfectly good mind when he tells it again and again that "da de da da" is the letter "Y", and he wonders how any mind can be so stupid. He is too harsh with himself.

Even when the student has progressed more or less steadily, and when he is about fast enough to secure a first grade license, his mind often seems to make no progress for weeks and even months at a time. Some students quit in disgust at such a time, little knowing that success waits just around the corner and that their minds have been working faithfully all the while.

Success does not come by speeding up the progress of copying down the letters as they are sent, but rather by forming new habits of hearing entire words and even phrases without paying specific attention to the individual letters which form them.

The radio code is a foreign language. No one could speak a language fluently if he stopped to spell each word to himself, no matter how fast his mind might work. He must think in phrases, which he has heard so often that his mind forms them almost automatically.

The operator who copies forty words a minute usually strains less than the beginner who copies ten. His mind does not work faster than the mind of the beginner; it merely works with fewer acts.

As the experienced operator sits at his typewriter and copies an important message coming, perhaps, from a statesman or a king, he changes the paper in his machine. He even tells a joke to another operator beside him, and maintains his normal rate of speed although he may have been working eight hours. He is at ease, and has none of the worry of the beginner who strains to catch every letter separately as it comes to him.

But he was once a beginner himself, and he strained his mind before he learned a better way. He first learned the dots and dashes which go to make up letters, and he learned them slowly, thinking them over as he went to sleep perhaps, and wondering when he would ever distinguish between Q and Y.

Some schools prefer that the students learn the letters by sound only and ask them never to look at charts which show the dots and dashes used for each letter. They may be in the right, for the sense of hearing is the one which is most concerned, and the sense which must be developed.

Not all minds are alike, however, in their processes of learning. The mind with the strongest visual memory no doubt makes better progress at the start by looking at a chart; such a mind must listen to the buzzer for the auditory sensation of the letter, and then refer to its visual memory to identify the letter by its arrangement of dots and dashes.

The visual process is a roundabout way, of course, and must soon be discarded for the simpler system of auditory memory. The auditory system of teaching, without the chart, is quite likely the best, although there is no way to prove it.

The beginner with a keen visual memory may often startle his friends with his rapid start, but learning the code is a true art which has no short cut, and sooner or later he slackens his pace, and his friends overtake him.

An ordinary mind can remember six figures when they are spoken, and can usually repeat them, both forward and backward. Some minds, of the keen visual type, can retain as many as ten or more figures "in the mind's eye," and repeat them at leisure. If such a mind exists in a class, and the instructor sends ten letters at a time, the student with the unusual mind can retain the letters and set them down at leisure usually to the astonishment of his classmates, most of whom have been unable to receive more than two or three of the letters.

Such a student will stand well in his class always, but if he is to become a fast operator, he must discard the visual processes and learn to write letters, words, and then phrases as he hears them.

Learning the code is much like solving a puzzle. Little Willie in the fourth grade humiliates his venerable old grandfather by learning the trick of it before grandfather, with all his great store of knowledge, has obtained a good start in finding the solution.

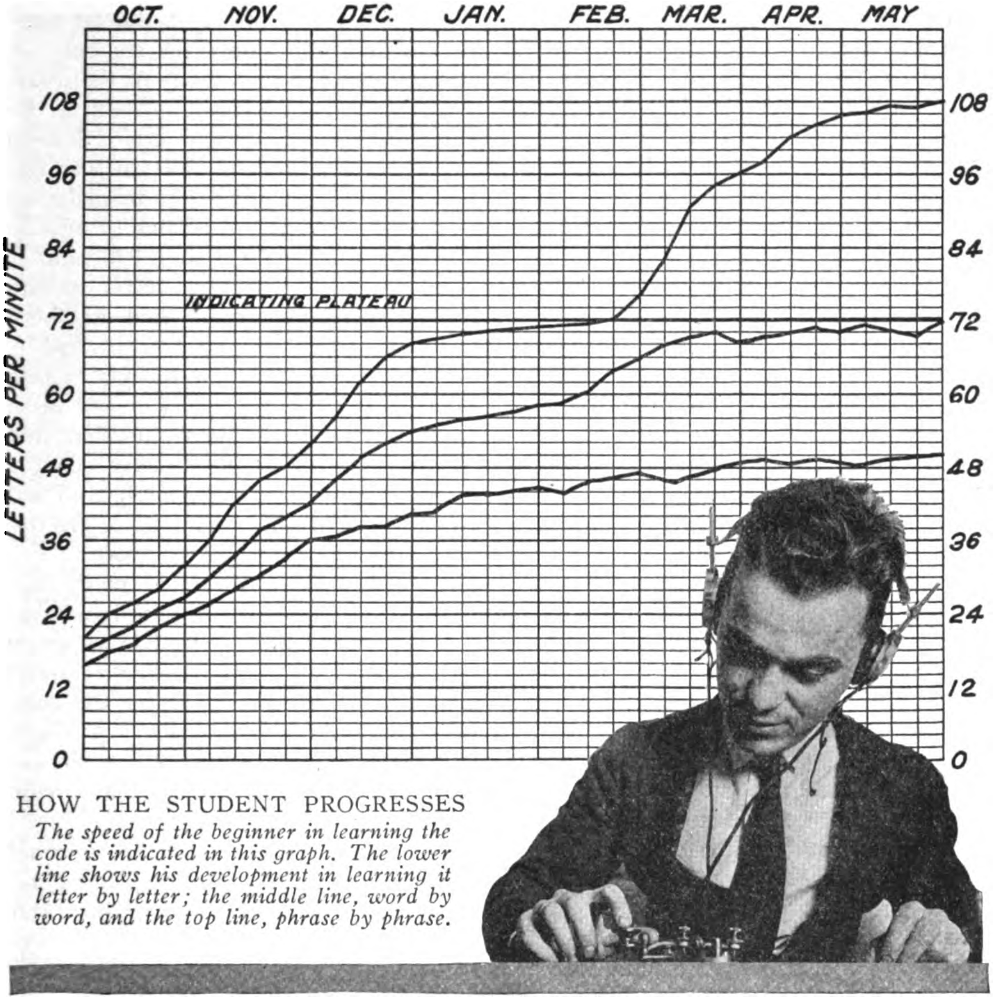
The code, in its democratic way, offers the same lengthy task to the old as well as the young and to the quick as well as the slow.

As the long and short buzzes come to the ear in a complex maze, the mind at first strains and can make nothing out of the confusion. It sounds like "oodle oodle de oodle" to the novice. The student in the classroom is almost as much at sea, even though the signals are much slower.

He is unable to distinguish between the letters at all until suddenly some feature catches his ear and helps to fix the signal in his mind. The single dash for T and the single dot for E are distinguished first as a rule, and other letters fix themselves in the mind much more slowly.

Perhaps the beginner discovers that the signal for Q is like the warning whistle of a train as it approaches a crossing; two long notes, a short one and then another long one. Thus, the similarity helps him to recognize Q when it comes to him slowly, but he must forget the similarity later if he is to become a fast operator. He will not have time to think "train whistle" before his pencil writes Q. He must make his actions more simple and automatically write Q, just as a German says *"rot"* or a Frenchman says *"rouge"* or a Spaniard says *"roto"* when he speaks of the color red.

He must not be discouraged if his pencil stands still when the buzzes of the



HOW THE STUDENT PROGRESSES

The speed of the beginner in learning the code is indicated in this graph. The lower line shows his development in learning it letter by letter; the middle line, word by word, and the top line, phrase by phrase.

letter Q come to him, even though he knows perfectly well, a second later, that the letter was Q. A mother must point many times to a hat or coat and say "red" before her baby finally understands, and the college instructor finds the same difficulty in teaching a foreign language.

If the mind is kept continually open and sensitive to the signals it will after a time eliminate errors and discover short cuts. The beginner who is discouraged needs only to recall his efforts in first learning to put on his collar and tie his necktie. His fingers were slow, and he invented many ways of pushing collar buttons through button holes until he found himself one day doing the trick seemingly without thinking anything about it.

During the process of learning the code, there are dull days, weeks and even months, during which periods the student seems to make no progress at all. Such apparently inactive periods may be caused by discouragement or inattention; perhaps the copying of messages seems too easy. At any rate, there is at least one period in the code student's progress as shown in the accompanying chart, when his mind seems to be at a standstill.

The curves shown on the chart represent the progress of a group of students who were learning telegraphy. The curves show in a general way how a student can expect his mind to act. In the curve marked "receiving" an inactive period or "mental plateau" is shown to occur during the fourth and fifth months of the student's efforts.

The accepted explanation of the plateau is thus set forth by Prof. R. S. Woodworth, of the Department of Psychology at Columbia University:

"The plateau is the figurative indication of a natural slowing down in the progress of the student during a period of study, and is followed ordinarily by signs of renewed impetus caused by the adoption of improved methods."

To progress from the plateau stage it is necessary not to increase the speed of the acts which the mind has already learned to perform, but to learn new habits of hearing words and even phrases in their entirety. Such new habits can come only from continued practice; while the mind seems to have gone stale, it is really getting a fresh start in a new direction as is shown decidedly by the abrupt upward trend of the curve after five or six months.

The plateau may come at the end of three, four or five months, and it may last much longer than a month or two, depending upon the individual's alertness. It is a bugbear to the student who does not understand it, but he should not be discouraged, for it comes to all beginners, regardless of their ability.

The beginner should learn, by all means, to "copy behind," that is, to write down the words several seconds after they are sent. This is the only safe method, for if he tries to keep up with the ticks he is apt to anticipate them and, hearing the first half of a familiar word, write the whole word and thus make mistakes.

Experts can copy from six to ten and even twelve words behind, depending upon their power to remember the words. They find it good practice to keep behind, for the meaning of the sentence may help them to make out a word of which they were not quite certain.

To shift from copying letters to copying words often stumps the student. At first he is sure to miss many of the words and his copy is hopelessly incomplete. He thinks it is better to copy letters, leaving out of uncertain ones and trusting that he will catch enough letters to make out most of the words. He hates to miss an entire word. It seems stupid to him.

He should realize that he is starting all over again, in a sense, and that he is learning *words* and *phrases* instead of *letters*. He must think of letters only when they come to him detached or in coded messages. He will find that such "mixed" messages will be easy enough; he will copy the words readily and will have plenty of time to think of the detached letters and figures.

The word-habit will cause many mistakes at first, but after a time it will not only be simpler but superior in accuracy.

Copying with a typewriter is much faster than with a pencil after the operator has learned the keys. A single movement in pressing a typewriter key takes the place of a series of movements in making a letter with a pencil.

To send with a telegraph key is much easier than to receive at first; that is because the fingers always know just what to do. As the chart indicates, a speed of some twenty words a minute is attained with almost steady progress.

The plateau in learning to send is not marked, although the hand can actually be made to think in words instead of letters and can acquire trains of action. A slight plateau is shown in the curve after about two months of practice. It is at this time that the hand is learning to send words instead of letters, and is busy learning the trains of action which form common words.

Perhaps the most obvious train of action in every day life is demonstrated unconsciously when we dress and undress. Almost everyone at some time has started to take off his shoes only and has suddenly awakened from his absent-mindedness to find that he has removed his

Form 772 a.

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION
LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

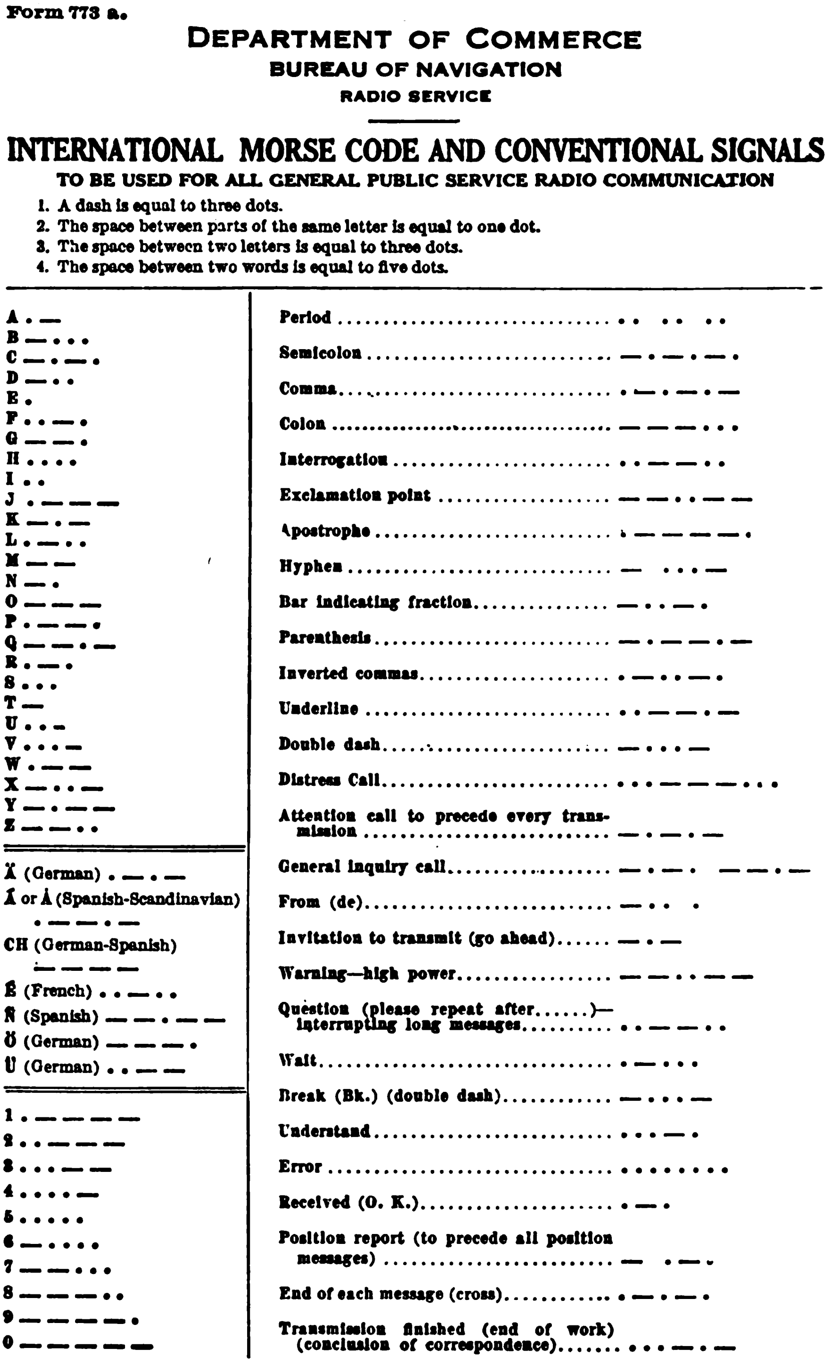
ABBREVIATION	QUESTION	ANSWER OR NOTICE
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is........
QRB	What is your distance?	My distance is.........
QRC	What is your true bearing?	My true bearing is........degrees.
QRD	Where are you bound for?	I am bound for........
QRF	Where are you bound from?	I am bound from........
QRG	What line do you belong to?	I belong to the........Line.
QRH	What is your wave length in meters?	My wave length is........meters.
QRJ	How many words have you to send?	I have........words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? · · · — · for adjustment?	I am receiving badly. Please send 20. · · · — · for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are the atmospherics strong?	Atmospherics are very strong.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with......). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No. ....
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad? Is my spark bad?	The tone is bad. The spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is........
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	....	Transmission will be in series of 5 messages.
QSH	....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for........?	Collect........
QSK	Is the last radiogram canceled	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is........degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with........)?	I am in communication with........ (through........).
QSP	Shall I inform........that you are calling him?	Inform........that I am calling him.
QSQ	Is........calling me?	You are being called by........
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at......o'clock)?	Will call when I have finished.
*QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wave length of........ meters?	Let us change to the wave length of........ meters.
QSZ	....	Send each word twice. I have difficulty in receiving you.
QTA	....	Repeat the last radiogram.
QTE	What is my true bearing?	Your true bearing is ..... degrees from .....
QTF	What is my position?	Your position is .... latitude .... longitude.

* Public correspondence is any radio work, official or private, handled on commercial wave lengths.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

THE NUCLEUS OF A UNIVERSAL LANGUAGE

These abbreviations are observed internationally; they constitute what is, in effect, the beginning of a world tongue. Every amateur who applies for a license to transmit must pass an examination on this list.



Form 773 a.

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL MORSE CODE AND CONVENTIONAL SIGNALS

TO BE USED FOR ALL GENERAL PUBLIC SERVICE RADIO COMMUNICATION

1. A dash is equal to three dots.
2. The space between parts of the same letter is equal to one dot.
3. The space between two letters is equal to three dots.
4. The space between two words is equal to five dots.

A	• —
B	— • • •
C	— • — •
D	— • •
E	•
F	• • — •
G	— — •
H	• • • •
I	• •
J	• — — —
K	— • —
L	• — • •
M	— —
N	— •
O	— — —
P	• — — •
Q	— — • —
R	• — •
S	• • •
T	—
U	• • —
V	• • • —
W	• — —
X	— • • —
Y	— • — —
Z	— — • •
Ä (German)	• — • —
Á or Å (Spanish-Scandinavian)	• — — • —
CH (German-Spanish)	— — — —
É (French)	• • — • •
Ñ (Spanish)	— — • — —
Ö (German)	— — — •
Ü (German)	• • — —
1	• — — — —
2	• • — — —
3	• • • — —
4	• • • • —
5	• • • • •
6	— • • • •
7	— — • • •
8	— — — • •
9	— — — — •
0	— — — — —

Period	• • • • • •
Semicolon	— • — • — •
Comma	• — • — • —
Colon	— — — • • •
Interrogation	• • — — • •
Exclamation point	— — • • — —
Apostrophe	• — — — — •
Hyphen	— • • • —
Bar indicating fraction	— • • — •
Parenthesis	— • — — • —
Inverted commas	• — • • — •
Underline	• • — — • —
Double dash	— • • • —
Distress Call	• • • — — — • • •
Attention call to precede every transmission	— • — • —
General inquiry call	— • — • — — • —
From (de)	— • • •
Invitation to transmit (go ahead)	— • —
Warning—high power	— — • • — —
Question (please repeat after......)—interrupting long messages	• • — — • •
Wait	• — • • •
Break (Bk.) (double dash)	— • • • —
Understand	• • • — •
Error	• • • • • • • •
Received (O. K.)	• — •
Position report (to precede all position messages)	— • — •
End of each message (cross)	• — • — •
Transmission finished (end of work) (conclusion of correspondence)	• • • — • —

THE KEY TO THE INNER CIRCLE OF THE ETHER

Fifteen minutes of study a day for a period of a month will give the average man (or woman) sufficient knowledge of the code to enable him to read most of the amateur signals. A buzzer practice set may be obtained for about two dollars.

hose and perhaps other garments as well.

The victim of such absent-mindedness has formed a train of action in undressing. He has followed this train in the same way for years, and when he once starts his mind on the train by removing his shoes, he continues without conscious effort.

In the same way the muscles of the hand learn to send common words in code. The operator has only to think the word; he does not think the letters. And his hand ticks it out. Common words such as "the", "and", "but", and "in" are learned almost at the outset. Endings of words such as "ing" and "ion" become automatic; after long training the hand acquires an extensive vocabulary of words which it sends in trains.

After three or four months the hand has approximately reached its muscular limit in the speed of sending letters and its progress from that time on comes in sending word trains which are not slowed down by the brain that thinks of each letter.

After a certain point in training is reached, sending is learned much more slowly than receiving because the mind can be trained to work much faster than the fingers; if a typewriter is used the operator can receive much faster than he can send. He can eventually find time to correct the sender's mistakes as he writes the message down.

Most beginners have heard of the "glass arm", but most of them do not take proper care to prevent it.

If the key is operated with the fingers or with the muscles of the hand, the continual strain will sooner or later cause temporary paralysis when the operator attempts to send with a key; this condition is known in the trade as the "glass arm." The operator may be able to write and use his hand in any other way, but when he attempts to send a message with a key, his hand and arm become rigid and will not obey him.

Almost any good operator can show the beginner how to place his fingers lightly on the key and make the movements with his wrist in the proper manner.

Progress at first will be much slower than would be the case if the student used his fingers to form the dots and dashes, but in the end the wrist movement is much the speedier. A tired hand or wrist is a danger signal and shows that the method of sending is wrong. A perfect wrist movement will enable an operator to send for hours, causing him little more fatigue than would come from writing a letter or other mild exercise of the hand and forearm.

RADIO PUTS SPEECH INTO MOTION PICTURE FILM

DURING *the recent brief visit to this country of Dr. Lee de Forest, arrangements were made with him to write for this magazine an article that will describe his latest experimental work with one phase of the de Forest audion tube activity about which but little has been written—its capacity to produce synthetic music from light! This development paves the way for that long-sought phenomenon—the motion picture film that talks.*

International

SIR ARTHUR CONAN DOYLE SAYS:

"I EXPECT *in the next three or four years some definite messages will be received to prove the contentions of the spiritualists. I believe they will come through radio. I think it is along this line that we will get our evidence. They have transmitters in the line of ether and all we have to have is the receiver. We will have the direct communication that Edison hoped for.*"

Are *the* Dead Trying *to* Reach Us by Radio?

The Second of a Series of Articles that Describes the Experiments of Psychic Investigators for Establishing Communication with a Possible Spiritual World through the Medium of Delicate Electrical Instruments

By HEREWARD CARRINGTON, Ph. D.

In the preceding article, published in the June number, Dr. Carrington pointed out the scientific possibility of some form of instrumental communication with a spiritual world, if such a world exists; granting the reality of such a world, communication with it through the medium of highly sensitive radio apparatus might conceivably be established.

The author pointed out that thought appears to be dynamic in its action, and sets up certain definite etheric radiations, which can apparently be detected. Such being the case, it would appear to be a short step to the construction of a possible "detector" delicate enough to register these ether impulses. Dr. Carrington believes we are on the eve of such a discovery, and it is upon this problem that he is now experimenting in the Psychical Laboratory in New York.

—EDITOR

THE all-pervading ether which science has stated surrounds us, penetrates every cell and molecule of our bodies and of our brains. Life must, accordingly, exist in this medium, insofar as we ourselves exist in it; insofar, indeed, as our minds and consciousness also exist in it. Mind is, therefore, in "contact" with it.

But what is ether? No one knows. Haeckel was inclined to believe that it is such a fine gas that a sphere of it the size of our earth would weigh but 250 pounds. Lodge, on the other hand, contends that it is more solid and dense than platinum and gold. Dr. Steinmetz, in this issue of Popular Radio, advances still another conception of it. Lord Kelvin said that no man could believe in the ether who did not also believe that it presented opposite and contrary properties. We can hardly dogmatize, then, as to the nature of this ether.

Is the ether atomic in structure? If so, what exists in its intra-atomic spaces? Another ether? I have already stated that occult science contends that there may be four ethers, one above or within the other. Certainly this theory may be accepted as a possibility. Various solid bodies can occupy the same space, if they are of differing densities. We can, for example fill a glass "full" of marbles; we can then fill in the spaces between the marbles with coarse shot; we can fill the spaces between these coarse shot with fine shot, and the spaces between the fine shot with water. It is conceivable at least, that this process may go on indefinitely; certainly we do not know where it may end. And just as air and ether carry different rates of vibration, as expressed in sound and light, so it seems reasonable to suppose that varying ethers, if they exist at all, may convey differing rates of vibratory activity, which are not detectible in another medium.

If this be true, the difficulty which has been experienced in detecting any form of brain waves or telepathic impulses may be explained. These impulses might exist, but be conveyed in some "mentiferous ether," as already suggested. When we discover that, then we shall immediately be enabled to register the waves which are operative in telepathy.

Already, Dr. E. E. Free, in a recent interview, has asserted his belief in the possibility of detecting such impulses electrically, by means of suitable instruments. He says:

> "There is no physical improbability that in the nerves of, say, the human brain exists some arrangement of tissues or of chemical molecules, competent to act as a wireless detector for such wireless impulses as may be sent out, as the result of nerve impulses originating elsewhere—as within other brains, for instance.
>
> "What would this be but telepathy?
>
> "But one must not become too speculative. Our only facts at present are that nerve energy is electrical, and that all electrical disturbances start wireless waves.
>
> "From these as an abutment we have built into the unknown what might be called a cantilever bridge of speculation . . . It has two essential members in its structure. One, the hypothesis that the wireless waves sent out are really sufficiently distinct and powerful to be detected by possible apparatus; and second, that such a receiving apparatus may exist within the human brain. . . ."

Both of these speculations surely seem rational.

It is not necessary to presume in such cases, that the thought itself is transmitted, any more than it is in wireless telephony. Only vibrations would be sent and received, and these vibrations would be re-translated upon arrival at their destination. Just as the chemical action in a battery remains in the battery, but is represented outside by its "dynamic correlate," known as the current, so in the case of the brain the dynamic correlate of thought, whatever that may be, remains in the brain. But its vibratory expression is transmitted outward into space, as a form of undulatory motion or ether waves.

To sum up my hypothesis, I may state:

In order to obtain a specific action we must employ a specific instrument—a telephone for a telephone, a brain for a brain.

Every living thing is a dynamic focus.

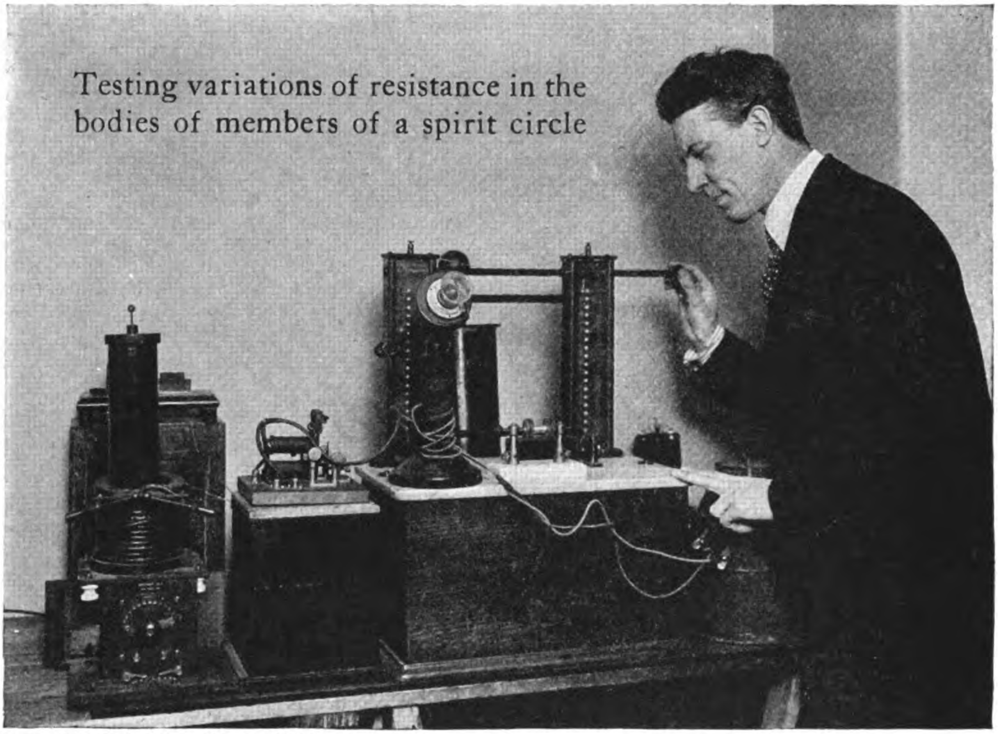
A dynamic focus tends ever to propagate the motion which is proper to it.

Propagated motion becomes transformed according to the medium it traverses; a force may be transmitted or transformed.

In an identical medium there is only transmission; in a different medium there is transformation.

If thought is dynamic in its expression, it may be transmitted and transformed. Then it may be re-transformed in another organism, which supplies the necessary conditions. Thought may be restored.

All this may be conceded so long as we have physical brains. But what of



Testing variations of resistance in the bodies of members of a spirit circle

From a photograph made for POPULAR RADIO

beings who no longer have such organs? What are we to say as to the inhabitants of some spiritual world? If such exist at all, they are certainly devoid of brains as we know them. How then, would any form of instrumental communication with such spiritual beings be possible or even conceivable?

First of all, it is now certain that the body itself does not feel, does not sense. The eyes do not see, the ears do not hear. It is the inner being within which sees, hears and senses. Physiology proves this. It has been contended that in addition to our physical bodies we also possess an etheric double, or "astral body," resembling the physical body in all its detail, and that it is this body which is the seat of the emotions, the feelings and the sensibilities. There is a great deal of actual evidence of the existence of some such invisible body. If certain French investigations are to be credited, it has been seen, felt and photographed; it has moved mechanical instruments; it has caused certain chemical screens (calcium sulphide) to glow with added brilliance when approached by it. Calculations have been made as to its density, structure and weight. According to these researches, we have a fairly good general idea as to its nature.

This invisible, inner body, then, may possibly be the vehicle of thought. It may possess centers whose normal office is to send and receive telepathic messages. One etheric center may thus act upon another etheric center directly, and only indirectly upon the physical brain cells. The action would thus be dynamic, yet psychical; physical in a sense, yet not physical as we conceive it. There is here a sort of physical communication of a spiritual thing. Its activity may take place in some higher ether or be some mode of activity in the ether which we cannot yet register. But that is no proof that such registration is impossible; on the contrary, it is my belief that it is possible, and will one day be registered. It seems, therefore, that it is merely a problem of developing sufficiently-attuned apparatus of the right kind, before we will detect and register these subtle mental vibrations. And these vibrations need not necessarily emanate from a physical brain, as we have seen. We may conceivably receive telepathic impulses from the dead!

The question which presents itself for practical solution, therefore, resolves itself down to this:

What sort of apparatus must we employ; what kind of detectors must we use, in order to register those etheric undulations which may be sent out from discarnate minds? And, having once detected and measured these wavelengths, what device could we construct which would enable us to send out the same sort of subtle etheric waves which, we may assume, would be somehow registered at the other end of the line? For if a definite wavelength can be transmitted, it is natural to suppose, *a priori,* that the same wavelength could be received by some inner mechanism.

The reader must not expect me to furnish him with a detailed list of blue prints, and say, "Construct a piece of apparatus in *this* manner, and you will receive messages and communications at once from the spirit world!" Were this possible, the problem would already have been solved; there would be no doubt concerning it at all. This cannot yet be done. But much can be done by clearing away doubts and misconceptions, by indicating the road which we must travel, and suggesting the kind of apparatus which must be employed, in order to obtain any possible results. Experiments of this character are now being made in the American Psychical Institute and Laboratory, and readers of this magazine may care to undertake experiments of a similar character. If so, I should be glad to hear from them and to receive reports of their investigations.

One of the first problems that we must solve, is to discover the nature and length of "brain waves" by experiments in telepathy. The two subjects may be placed in a high-tension electric field, or in a space across which carrier waves of known length and frequency are passing. These carrier waves, as already suggested, would doubtless reinforce and possibly render evident the etheric undulations that are operative in telepathy. If these could then be detected and calibrated, we should have made our first definite forward step toward an understanding of direct mental action, expressed through a certain machine—in this case the human body and brain.

Then we should devise a suitable detector, capable of registering these ether waves with accuracy and facility. Once the detector had been perfected, the next step would be the perfection of a sending apparatus, emitting the same form of wavelengths at the same frequency.

Experiments should also be tried in obtaining possible direct pressures and registrations by subtle forces. The mere exercise of an energy in itself would prove little; but if it manifested signs of intelligence, then we should have something of value and significance.

Doctors Matla and Zaalberg van Zelst, of The Hague, Holland, claim that they have already received direct communications in this manner, when no medium at all was present. Their apparatus was elaborate; the principle of it was as follows: The letters of the alphabet were painted on a flat disk, which slowly revolved. One letter at a time appeared in an opening that was cut in a card that covered this disk. Lower down, was the "key" of the instrument; it consisted of a flat plate, very delicately balanced; the slightest pressure on it would complete an electric circuit. When this key was pressed by some invisible being or force, at that moment the letter "M" (say) appeared in the opening above and this letter was automatically printed on a sort of ticker-tape.

In this way the messages were spelled out; long messages, it is claimed, were recorded and were published in a book entitled "The Mystery of Death," pub-

From a photograph made for Popular Radio

MEASURING THE PSYCHO-GALVANIC REFLEXES OF A MEDIUM

Our body is in effect an electric battery; its power varies with our mental activity and our emotions. By means of a galvanometer the current impulses may be measured to 1-millionth of an ampere. Dr. Carrington believes that thought impulses from a spiritual world may some day be recorded on some such highly sensitive instrument.

lished first in Dutch and later in French.

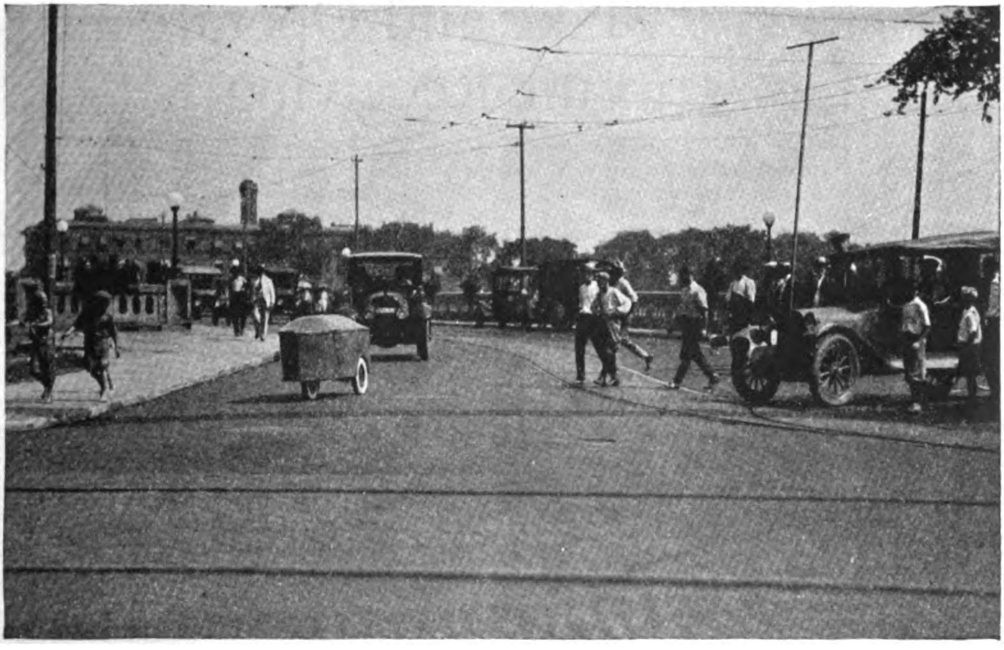
It is possible, however, that messages of this character cannot be received unless some other factor be present, and that factor is life. Vital force, vital energy, life—whatever that may be—seems to be a necessary factor in nearly all these manifestations, and it is possible that we cannot obtain them without its presence, directly or indirectly. This life force seems to be utilized, in some mysterious way, and rapidly expended in the production of many of these phenomena; but the close relationship between life and electricity should not be lost sight of in this connection. Is there not a bridge between the two—a bridge which can be discovered, uniting and connecting them? And across this bridge may not action and interaction take place, of a nature hitherto unsuspected? It seems rational to suppose so. We stand here upon the border line of life and matter, in that mysterious realm that connects soul and body, and it is here that discoveries of the greatest significance will assuredly be made in the near future.

We already have, in our Psychical Laboratory, instruments that detect the differences between various bodily radiations and devices which record the energy-changes of members of a circle. Radiations from the body, and especially from the finger-tips, appear to be proved. Yet if this be true, we have here cases of nerve-energy, or life-force, that exists outside the body, in space, that acts and reacts upon other forces and energies. If this "externalization" of life force be a fact, it opens up the possibility of conducting and even collecting it, and applying it like any other energy. If it could be "caught," as it were, we should then have this vital intermediary between the material and spiritual worlds, and be enabled to utilize it for communication.

All sorts of fascinating possibilities come to the mind. If life, leaving the body at death, could be registered in some manner, might not experiments be conducted with this in view? We know that there is all the difference in the world between a living and a dead man; yet no physical change may be detectable. Something has, nevertheless, left the living man and that something is his life. If life could be somehow registered or "caught," at the moment of death, we should have here immediate proof of its persistence after the destruction of the physical body. Whether or not this life force contained a mind, consciousness and personality of its own would be another question—a question capable of solution, however, by proper methods of careful, scientific, psychical investigation.

Thus it would appear that a possible method of communication with some spiritual world—granting that it exists—may some day be established by means of highly sensitive radio apparatus that may record impulses too delicate to register on machines that have so far been devised. Such an idea is not as fantastic as might appear at first thought. Without departing essentially from recognized scientific facts or accepted psychical phenomena, I have shown that some such method of communication might be established in the future, when our methods of research have been more fully perfected. When our young experimentalists, especially in radio, begin working in this direction we may hope for startling results.

¶ This article will shortly be followed by an article written by Harry Houdini, president of the Society of American Magicians, who will describe how the fakers among the spiritualists have been using radio for years in staging tricks at their seances.



A RADIO-CONTROLLED MOTOR CAR ON A CITY STREET

Among the more spectacular achievements with radio, few have a wider interest than the guidance of cars, boats or airplanes from a distance. How this is done will be told in "How Machines Are Controlled by Radio," by Dr. Henry Smith Williams—in the August POPULAR RADIO.

From a photograph made for POPULAR RADIO

THIS HOME-MADE SET COSTS FROM $15.00 to $22.00 FOR MATERIALS

Fastening the secondary coil to the sliding support. This sliding coil makes it possible to tune out interference on this set.

How *to* Make and Operate a Two-Circuit Receiving Set

Further evidence of the purpose of the Government authorities to encourage radio amateurs is furnished by these specifications, which have been carefully worked out by the Bureau of Standards, and issued as a sequel to the specifications of the crystal receiving set which were published in the May issue of this magazine.

By WATSON DAVIS

UNCLE SAM is telling the radio fan how to make his own receiving equipment that will enable him to snatch his share of the music, lectures, code and other wireless activity in the ether. The Bureau of Standards, Department of Commerce, cooperating with the Bureau of Markets, Department of Agriculture, has compiled these simple instructions for the amateur.

At a total cost of from about $15 to about $22, depending upon the quality of the telephone receivers and the condenser purchased, he can make an efficient radio receiver right at home that can distinguish between messages from different transmitting stations sent on wavelengths nearly the same. The outfit will enable anyone to hear radio code messages or music and voice sent from medium-power transmitting stations within an area about the size of a large city, and from high-power stations within fifty miles, provided the waves used by the sending stations have wave frequencies between 500 and 1500 kilocycles a second—that is, wavelengths between 600 and 200 meters. This equipment will not receive undamped (continuous) waves.

This set is superior to a single-circuit outfit as it is more selective, that is, it can be tuned sharper. Those who have constructed the Bureau of Standards single-circuit $11 radio receiver according to instructions published in the May issue of this magazine can utilize all the parts of that set in making the better outfit described here.

The instructions tell how to make all the parts of a receiving station except the antenna, lightning switch and necessary ground connections. How to make and erect an antenna and make necessary connections to the receiving set was explained in the previous article.

Parts of the Set

The two-circuit receiving set consists essentially of a coupler, a variable condenser, a crystal detector, and accessories.

The assembled receiving set is shown in Figure 1, and Figure 2 shows how to wire the set.

The coupler, shown in left half of Figure 1, is composed of a fixed section made up of the coil tube P, the upright J, the contact panel K, and the base B, and a movable section composed of coil tube S, the supporting contact panel M and the base L.

The Movable or Secondary Coil

The coil tube S, (Figure 1), is a piece of cardboard tubing 3⅝ inches in diameter and 4 inches long. A round cardboard table-salt box which can be obtained at a grocery store is about 3⅝ inches in diameter and can be used for this purpose. One of the cardboard ends or caps should be securely glued to the box. This tube is wound with No. 24 (or No. 26) double cotton covered copper wire.

To wind the wire punch two holes in the tube ⅜ inch from the open end, as shown at R, Figure 2. Weave the end of the wire through these holes so that it is firmly anchored and has one end extending about 10 inches inside the tube. Punch a hole F about ⅝ inch from the other end (which has the cardboard cover secured to it) in line with the holes punched at R. Draw the free end of the wire through the inside of the tube and thread it out through the hole at F. Now wind on 10 turns of wire and take off a 6-inch twisted tap made by twisting a 6-inch loop of wire together at such a place that it will be slightly staggered from the first connection. Hold the turns tight and punch a hole B directly underneath this tap. Insert the end of the tap in the hole and pull it through the inside of the tube so that the turns are held in place. The hole for this tap should be slightly staggered from the first two holes which were punched. Punch another hole L ⅝ inch from the other end of the tube and in line with the hole B. Thread the twisted tap out through this hole and pull it tight. Wind on 10 more turns and bring out another twisted tap, then 10 more turns and another tap; 15 turns and another tap; 15 more turns and another tap. Finally, wind on 20 more turns and bring out the free end of the wire in the same manner as the taps were brought out. The tube now has 80 turns of wire wound on it and there are 5 twisted taps and two single wires projecting through the row of holes at the closed end of the tube. The position of the wires inside the coil tube is shown by the dotted lines.

The Base and Support for Coil

The contact panel M, Figure 1, which supports the coil tube is a piece of dry wood or Bakelite 5½ inches high, 4 inches wide and ½ inch thick. The end of the switch arm should be wide enough so that it will not drop between the contact points, but not so wide that it cannot be set to touch only a single contact. Having located the hole for the switch-arm bolt, the switch arm should be placed in position and the knob rotated in such a manner that the end of the contact arm will describe an arc upon which the contact points are to be placed. The holes for the contacts should next be drilled, the spacing depending upon the kind of contacts which are to be used.

The movable base L is a square piece of dry wood 4 inches long, 4 inches wide and about ¾ inch thick. Care should be taken to have the edges of this block cut square with respect to the sides.

Now screw panel M to the movable base L, as shown in Figure 1. Care should be taken to have the edges of the blocks M and L evenly lined up so that the two edges of the block L, Figure 1, which slide along the inside edges of the strips H and I will be smooth continuous surfaces.

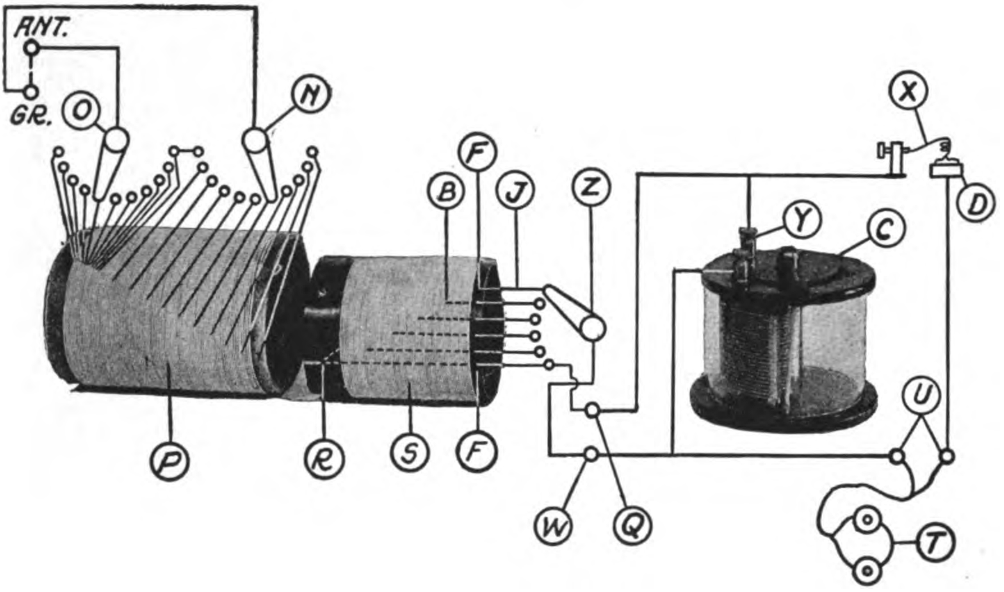
The Parts Needed and the Approximate Cost

You will have to buy these parts of the set, or find them around the house:

6 ounces No. 24 double cotton covered copper wire	$ .80
2 round cardboard boxes	
3 switch knobs and blades, complete	1.50
24 switch contacts and nuts	1.00
3 binding posts; set-screw type	.45
4 binding posts; any type	.60
1 crystal; tested	.25
3 wood screws; brass, ¾ inch long	.03
2 wood screws for fastening the panel to the base	.02
Wood for panels (from a packing box)	
2 pounds paraffine	.30
Lamp cord; 2 to 3 cents a foot	
Telephone Receivers	4.00 to 8.00
1 battery clip for crystal	.10
Miscellaneous Screws	.30
1 variable condenser; 0.0004 to 0.0005 microfarads (400 to 500 micromicrofarads)	3.00 to 6.00

The Fixed or Primary Coil

The cardboard tubing or coil tube P is 4⅛ inches in diameter by 4 inches long. About 2 ounces of No. 24 (or No. 26) double cotton-covered copper wire is used for winding the coil. Punch two holes in the tube about ½ inch from one end. Weave the wire through these holes in such a way that the end of the



From a design made for **Popular Radio**

FIGURE 1

What the electrical parts of the receiving set are, combined with a diagram that illustrates the system of wiring.

wire will be firmly anchored, leaving about 12 inches of the wire free for connecting. Start with the remainder of the wire to wind turns in a single layer about the tube, tight and close together. After one complete turn has been wound on the tube hold it tight and take off a tap. This tap is made by twisting a 6-inch loop of the wire together at such a place that it will be slightly staggered from the first connection. Proceed in this manner until 10 twisted taps have been taken off, one at every turn. After these first 10 turns have been wound on the tube, take off a 6-inch twisted tap for every succeeding 10 turns until 10 taps are taken off or 100 additional turns have been wound on the tube. After winding the last turn of wire anchor the end by weaving it through two holes punched in the tube as at the start, leaving about 12 inches of wire free for connecting. It is to be understood that each of the 21 taps is slightly staggered to the right from the one just above, so that the taps will not be bunched along one line on the cardboard tube. (See Figure 2.) It might be advisable, after winding the tuning coil, to dip the tuner in hot paraffine. Glue a cardboard cover to the end of the tube where the single turn taps are taken off.

The Panel

Panel K should be made from a board 7½ inches long by 4½ inches wide and about ½ inch thick. The position of the contacts can best be determined by inserting the switch arms in their respective holes and turning the knobs so that the ends of the switch arms will describe arcs. The position of the several holes for the binding posts, switch arms and switch contacts may first be laid out and drilled. The "antenna" and "ground" binding posts may be ordinary 8/32 brass bolts about 1½ inches long with three nuts and two washers. The first nut binds the bolt to the panel, the second nut holds one of the short pieces of stiff wire, while the third nut holds the antenna or ground wire as the case may be. The switch arm with knob may be purchased in the assembled form or it may be constructed from a ⅜-inch slice cut from a broom handle and a bolt of sufficient length equipped with four nuts and two washers, together with a strip of thin brass. The end of the switch arm should be wide enough so that it will not drop between the contact points, but not so wide that it cannot be set to touch only a single contact. The switch contacts may be of the regular type furnished for this purpose or they may be 6/32 brass bolts with one nut and one washer each.

The fixed base B is a piece of dry wood 5½ inches wide, 19 inches long and between ¾ and ⅞ inch thick. The support J for the fixed coil tube is 5½ inches wide (the width of the base), 6 inches long and about ½ inch thick. This board should be screwed to one end of the base so that it is held securely in a vertical position. It will then project about 5 inches above the base B.

A strip of wood I, 11 inches long, 5/16 inch wide and about ¼ inch thick is now fastened to the base by cigar-box nails or small brads so that it is even with the rear edge, as shown in Figure 1. The upright panel M having been fastened to the movable base L, as previously explained, is placed in position as shown. The next step is to locate the strip H in such a position that the block L will slide easily back and forth the entire length of the fixed base B. Having found this position this strip is secured in the same manner as the strip I. It is, of course, understood that neither the movable coil tube S nor the switch contacts and binding posts have, up to the present time, been mounted on the upright panel M. The wooden parts for the loose-coupler are now finished and should be covered with paraffine.

It might be advisable after winding the coil tubes P and S to dip them in hot paraffine. This will help to exclude moisture. Have the paraffine-heated until it just begins to smoke so that when the coils are removed they will have only a very thin coating of paraffine.

The Variable Condenser

The variable air condenser C should have a maximum capacity of between 0.0004 and 0.0005 microfarads (400 to 500 micromicrofarads.) The type pictured in Figure 1 is inclosed in a round glass case, but the "unmounted" type may also be used. The variable condenser is mounted on the base B, Figure 1. After the holes for the detector binding post, and also the holes for the telephone binding posts U have been drilled, the board should be coated with paraffine.

The Crystal Detector

The galena crystal D may be mounted as pictured in Figures 1 and 2. The holder for the crystal is a metallic pinch-clip such as the ordinary battery test clip or paper clip. This clip should be bent into a convenient shape so that it may be fastened to the base.

The wire X which makes contact with the crystal is a piece of fine wire (about No. 30) which is wound into the form of a spring and attached to a heavy piece of copper wire (about No. 14). This heavy wire is bent twice at right angles, passes through the binding post, and has a wood knob or cork fixed to its end as shown. It is desirable to have the fine wire of springy material such as German silver, but copper wire may be used if necessary.

The importance of securing a tested galena crystal can not be emphasized too strongly, and it should be understood that good results can not be obtained by using an insensitive crystal.

Assembling the Coupler

The movable portion of the coupler should be assembled first. As shown in Figure 1, the fittings making up this part of the set are the movable base L, the coil tube support M and the coil tube S. Insert in M the 6 switch contacts (machine screws), the switch arm, and the binding posts, in the proper holes which have been drilled. Adjust the switch arm until it presses firmly on the contact points (bolt heads) and fasten the bare end of a No. 24 copper wire between the nuts on the end of the switch-arm bolt 2, Figure 2, which projects through the panel M. Wind this wire into the form of a spiral of two or three turns like a clock-spring, leaving a few inches of the wire for connection. Insert two small screws V, Figure 1, in the panel M so that the switch arms will not drop off the row of contact points when the knob is turned too far.

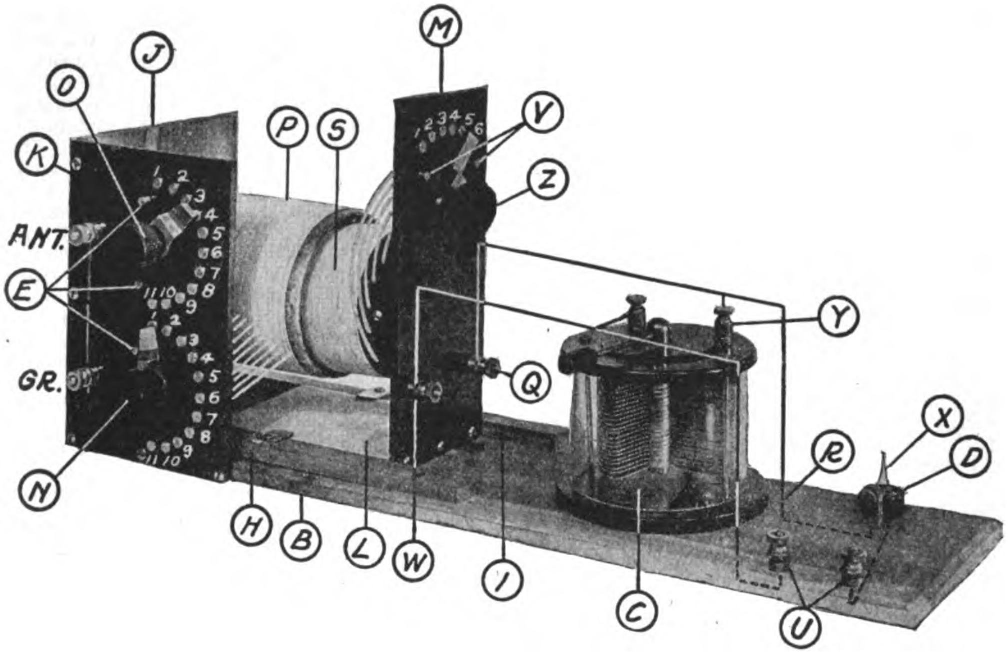
The coil tube S is now ready to be fastened in position on the panel M. Cut a 1-inch hole in the cardboard end of the coil tube and place it with the closed end next to the panel M in such a position that it will be just below the row of nuts and washers (switch contacts) and in the center of the panel M with respect to the sides. Fasten it to the panel with short wood screws. The switch-arm bolt with the spiral wire connected to it should project through the hole cut in the end of the coil tube. Thread the end of this wire through a hole punched near the end of the coil tube next to the panel and connect this wire to the back of the binding post, W, Figures 1 and 2. The wire F, Figure 2, is now connected to the back of the binding post Q. There now remain 5 twisted taps and 1 wire to be connected to the 6 switch contacts. The taps should be cut off about 1½ inches from the coil tube and the insulation removed from the pairs of wires thus formed. Each pair of wires should be twisted together, as shown at J, Figure 2. The connections are now made by clamping the 5 taps and also the end of the single wire between the nuts and washers on the contact bolts. The connections are clearly shown in the diagram.

We are now ready to assemble and wire the fixed portion of the coupler, composed of the Base B, coil support J, panel K and coil tube P.

Screw the panel to the base and to the support J and insert the binding posts, switch arms and bolts, and contact bolts in the proper holes. The switch arms should now be adjusted so that they make firm contact on the heads of the bolts. Now insert 4 small screws, E, Figure 1, in the front of the panel so that the switch arms will not drop off the row of contact points when the knobs are turned too far. Insert a wire between the nuts on the end of the lower switch-arm bolt N where it projects through the back of the panel K, Figure 1. Wind the wire into a spiral of 1 or 2 turns like a clock-spring and connect the end to the upper binding post which is marked "Antenna." These connections will be understood by referring to the upper left-hand corner of Figure 2.

In the same manner connect another wire from the upper switch-arm bolt to the lower binding post which is marked "Ground." See Figure 2. The connecting wires should be insulated except where a connection is needed and should not touch each other. Two short pieces of wire are now fastened to the binding posts in the front of the panel, as previously explained.

The coil tube P should now be laid on the base in about the same position as it is shown in Figure 1. The 19 twisted taps and also the 2 single wires from the ends of the winding are now to be connected to the back of the 22 contacts on the panel K. Scrape the cotton insulation from the loop ends of the nineteen twisted taps as well as from the ends of the two single wire taps coming from the first and last turns. Fasten the bare ends of these wires to the proper switch contacts. Be careful not to cut or break any of the looped taps. The connecting wires may be fastened to the switch contacts by binding them between the washer



From a photograph made for POPULAR RADIO

FIGURE 2

How the parts of the set are assembled. This set will receive satisfactorily within an area of any large city, from medium-power stations and from high-power stations within 50 *miles.*

and the nut. The order of connecting the taps may be understood by referring to Figure 2.

Carefully raise the coil tube P against the support J to such a position that when the coil tube S of the movable section of the tuner is pushed in the coil tube P, the space between the two tubes will be equal all around. Mark this position of the coil tube P on J, and fasten it to J with short wood screws.

Wiring the Condenser and Crystal Detector

The mounting of the condenser C and the crystal detector D on the base R is clearly shown in Figure 1. A wire is run from the binding post Y on the variable condenser C, through a small hole in the base R, and is then connected to the under side of the detector binding post. Another wire is now run from the clip which holds the galena crystal, through a small hole in the base, and is then connected to the under side of the right-hand binding post U. The left-hand binding post U is next connected to the binding post on the variable condenser which has no wire attached to it, by running a wire under the base and up through a small hole. The wiring will be understood by referring to the right-hand portion of Figure 2. The wires may be the same size as were used for winding the coil tubes and should be insulated. Two pieces of wire should now be connected from the binding posts W and Q, Figures 1 and 2, to binding posts on the variable condenser. The telephone receivers T are now connected to the binding posts U and the receiving set is complete except for connecting to the antenna and ground.

Connect the antenna lead and ground wire to the binding post marked "Antenna" and "Ground."

Directions for Operating

Push the coil tube S (secondary) about half way into the coil tube P (primary) and set the switch Z on contact point 4. The primary switch O may be left in any position. The wire which rests on the crystal detector must be placed lightly at different points on the crystal until the transmitting station is heard when the set is adjusted as described below. During this operation the primary switch N should be set on contact point 5.

Having adjusted the crystal detector to a sensitive point, the next thing is to adjust the switches on the coil tube P (primary), the switch on the coil tube S (secondary) and also the variable condenser C, so that the apparatus will be in "resonance" with the transmitting station. Set the primary switch N on contact point 1, and while keeping it in this position move the other primary switch O over all of its contacts stopping a moment at each one. Care should be taken to see that the ends of the switch arms are not allowed to rest so that they will touch more than one contact point at a time. If no signals are heard, set the switch arm N on contact point 2 and again move the switch arm O over all of its contacts. Proceed in this manner until the transmitting station is heard. This is called "tuning" the primary circuit.

The tuning of the secondary circuit is the next operation. Set the secondary switch Z on contact point 1 and turn the knob of the variable condenser C so that the pointer moves over the entire scale. If now signals are heard, set the switch on contact point 2 and again turn the knob of the variable condenser so that the pointer moves over the entire scale. Proceed in this manner until the signals are loudest, being careful to see that the ends of the switch arms touch only one contact point at a time. Next slide the coil tube S (secondary) in and out of the coil tube P (primary) until the signals are made as loud as possible. This operation is called changing the "coupling." When the coupling which gives the loudest signal has been secured, it may be necessary to readjust slightly the position of the switch arm O, the position of the movable coil tube S and the "setting" of the variable condenser C.

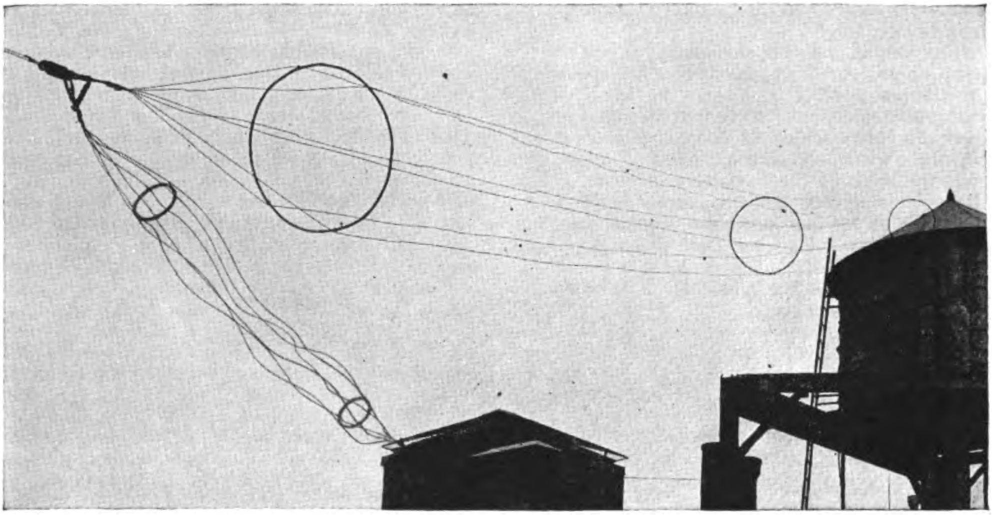
The receiving set is now in resonance with the transmitting station. It is possible to change the position of one or more of the switch arms, the position of the movable coil tube and the setting of the variable condenser in such a manner that the set will still be in resonance with the same transmitting station. In other words, there are different combinations of adjustments which will tune the set so that it will respond to signals from the same transmitting station. The best adjustment is that which reduces the signals from undesired stations to a minimum and still permits the desired transmitting station to be heard. This is accomplished by decreasing the coupling (drawing coil tube S farther out of coil tube P) and again tuning with the switch arm O and the variable condenser C. This may also weaken the signals from the desired transmitting station, but it will weaken the signals from the undesired stations to a greater extent, provided that the transmitting station which it is desired to hear has a wave frequency which is not exactly the same as that of the other stations. This feature of the radio receiver is called "selectivity."

¶ *"Fighting Fire by Radio"—where and how the Forest Service has been using wireless successfully and saved Uncle Sam millions of dollars—will appear in the next issue of* POPULAR RADIO.

© Harris E. Ewing

WHERE YOUR RADIO CALL LETTERS ARE ASSIGNED

This is the inner sanctum of Uncle Sam's radio office—officially designated as the "Radio Service, Department of Commerce"—and the official at the extreme right is Mr. W. D. Terrill, the man who decides what call letters shall be. How the system works, and what your call letters signify will be described in the next issue of POPULAR RADIO.



From a photograph made for POPULAR RADIO

The carefully designed and skilfully made cage antenna on the roof of an apartment building.

An Amateur Who Hears Europe

Have You Ever Heard Station 2BEA Transmit? Here Is a Description of Its Radio Equipment

By RICHARD LORD

WHILE walking up West End Avenue, New York, my eye was attracted by a carefully designed and skilfully made cage antenna, located on a tall apartment building. It was obviously the work of an experienced amateur. I noted that the lead-in continued as a diminutive cage to the window insulator. One look at this shipshape piece of work convinced me that it would be worthy examination, so I got into touch with the owner.

The owner was Mr. William Schweitzer, operating station 2BEA, an amateur of experience with a sound knowledge of the principles of radio.

The first C.W. transmitter which Mr. Schweitzer had operated consisted of four 5-watt tubes. With this small power output he did extraordinary work. On one occasion he was copied in Jefferson City, Missouri, a distance of 1,200 miles, by daylight.

Recently the 5-watt tubes have been replaced by a home-made set that employs two 50-watt tubes to generate the continuous waves. The plate potential is supplied from the secondary of a step-up transformer rectified by means of two Kenotron tubes. The actual voltage supply to the plates is approximately 1250. The circuit used is a Colpitts, employing capacity coupling between the plate and grid circuits.

The evening I called the static was unusually heavy for an early March evening, but a good deal of traffic was handled southwards. Savannah, Georgia, was raised on the first call and messages were put through without repeats.

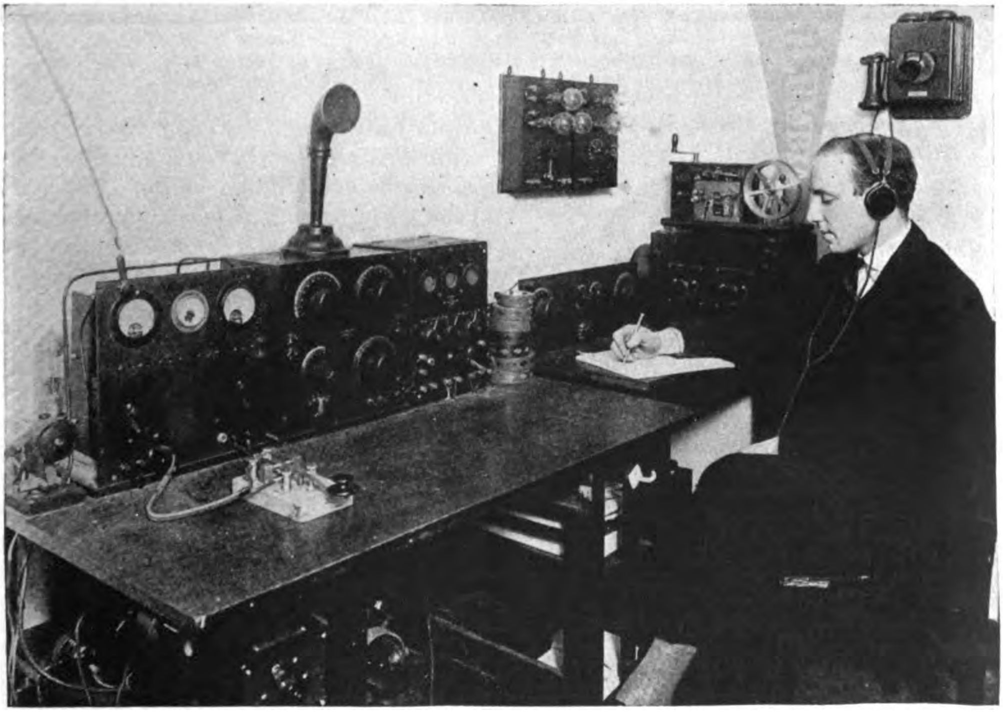
The relay receiver is a Grebe CR4 with a vacuum tube detector and two stage audio frequency amplifier.

In addition to the relay equipment, Mr. Schweitzer has an excellent long wave apparatus for trans-Atlantic and trans-Pacific reception. The long wave tuner is a conventional honeycomb unit with the primary and secondary inductances shunted by a pair of very fine Kloster design condensers. A special long single wire antenna is used for long wave reception. The incoming energy is first amplified by three stages of radio frequency amplification. The radio frequency amplifier was especially constructed by Roget, of Paris; it employs three French valves and is resistance coupled. This device is remarkably silent in operation and very compact.

The magnified current is then supplied to the receiving tuner. The output in turn is passed through three stages of audio frequency amplification. The three stage audio amplifier is also built by Roget, and employs French tubes. Of course, one will readily believe that this equipment brings in signals of extraordinary strength. Ample energy is received from any of the stations generally copied on this side to operate the Morse relay recording device, which is a part of the station's equipment.

The radio station is located in a little building on the roof. In order to be able to hear the signals in the apartment, ten stories below, Mr. Schweitzer uses a Magnavox, which is supplied through a wire line running to the station. A step-down transformer is used to couple the output of the receiving set with the Magnavox. The music from the Newark broadcasting stations can be heard more than a block from the apartment when the Magnavox is on the windowsill.

Although there is much expensive equipment in the station, the remarkable results obtained are not dependent upon this equipment; they are due to the skill and careful workmanship which are displayed in the assembling and construction of the units. The 100-watt C.W. transmitter has been constructed in its entirety by Mr. Schweitzer.



From a photograph made for POPULAR RADIO

Good results from your radio set may be obtained not alone from good apparatus but from proper installation and maintenance—as William Schweitzer has demonstrated with his station 2BEA, a part of which he built himself.

How High Frequency Currents Are Generated

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 3

By LAURENCE M. COCKADAY

From a photograph made for POPULAR RADIO

This picture shows a spark jumping the gap. The large coil (in the rear) and the enclosed condenser (at the right) comprise an oscillating circuit.

IN the two preceding articles we have learned how electricity is generated and what it is; we have acquired a general idea of what a radio wave is and how it is sent out through space. We have been told that the radio wave is set up in the vicinity of a transmitting antenna only when a current of extremely high frequency is caused, by some means or other, to flow back and forth, or oscillate through an antenna circuit. This radio wave has a definite wavelength for every given frequency of current that is caused to flow in the antenna circuit.

In this third article of this series we will delve into the seemingly mysterious methods employed for producing these high frequency currents and also into the methods of controlling the frequency of these currents whereby a transmitting station may "tune" itself to a wavelength alloted to its use by the government. The case that we will now study is the generation of high frequency currents by the spark discharge method.

—EDITOR

MANY of us who have walked past the radio cabin on a steamer have heard the crashing, sparking sounds that issue from the radio transmitter. Some of us have seen the sets in operation. Most of us have perhaps turned away with the thought: "Well, radio certainly is a wonderful thing, and it must have taken some brain to work out the idea, but it's beyond me."

This, however, is not so. Anybody can understand the mechanics of radio if given the right instruction.

In the last article we became slightly familiar with two electrical instruments—the inductance or coil, and the condenser. We learned that these two pieces of apparatus were storehouses of energy. The coil we found had the ability to store up electromagnetic energy. This meant that the coil produced an electromagnetic field around itself that was similar to the field set up around a steel permanent magnet. The condenser on the other hand, by having all the electrons drawn off one plate and crowded on the other plate, became "charged." This caused one plate to be positive, and the other to be negative. The plate which contained all the electrons was the plate that was charged negatively. These two charges caused the "dielectric" or insulation between the two metal plates to be placed in a stressed or strained condition; in other words, an electrostatic field was set up in the insulation.

We will now connect up these two instruments with a spark gap and show how they, in combination, will cause wave trains of high frequency currents to be generated and how they also can be varied in size so that the frequency of the oscillations can be controlled at will, thus controlling the wavelength emitted from the transmitting set of which they form a part.

If we connect a wire to one plate of a condenser, which is made for high voltages, and which is diagrammatically shown at C in Figure A, and also connect the other end of this wire to one electrode of a spark gap SG, and connect the other plate of the condenser C to another wire which is attached to one end of a coil L, and further connect the other end of the coil to another wire which is in turn connected to the remaining electrode of the spark gap SG, we have connected up a regular oscillating circuit such as used by spark radio telegraph stations for generating the oscillations necessary for the production of the Hertzian or radio waves.

Now we will continue and make the circuit oscillate for our inspection in a very slow manner so that we may comprehend the workings clearly. Of course this will be unnatural, but it will serve to show us the functioning of the circuit in much the same way as motion pictures are slowed down so that the observer may see each individual action.

We will first place a charge on the condenser C; a positive charge on the upper plate and a negative charge on the lower plate, Figure A. As we have already learned, a condenser when charged, contains a store of energy which is in the form of electrostatic electricity, or stationary electricity.

When a condenser is charged in this manner it tries to discharge and thus neutralize the charges on the plates. This discharge cannot take place unless the condenser has some external, electrically conducting path through which the electric current may run. This conducting path may be a wire attached from the positive plate to the negative plate. Inspection of Figure A shows that we have these conditions fulfilled except for one point—the air gap between the electrodes of the spark gap. Therefore, if we wish the electric charges on the condenser to discharge through the circuit we must place a high enough voltage on the plates so that the resistance of the air between the electrodes will be overcome and a spark allowed to jump across the gap. Then we have a complete conducting circuit from the upper plate to the lower plate of the condenser and a cur-

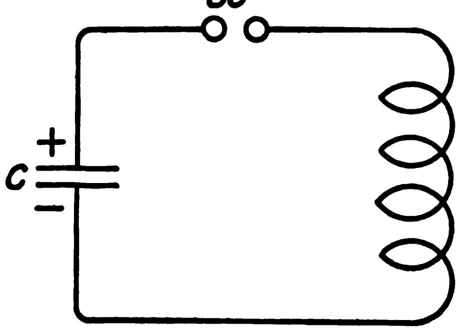


FIGURE A

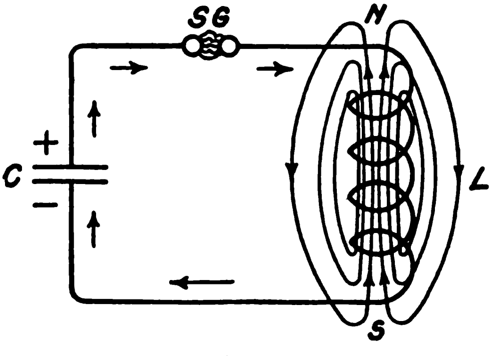


FIGURE B

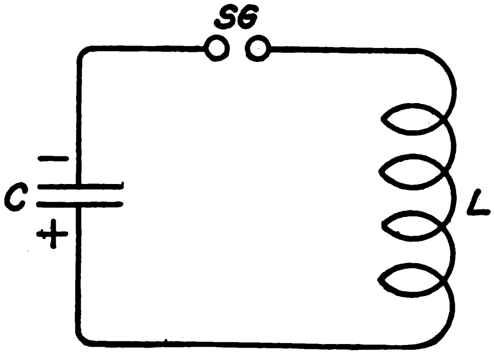


FIGURE C

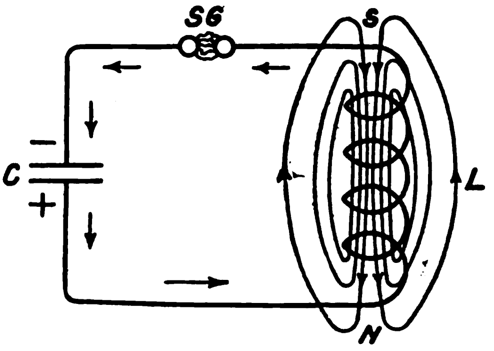


FIGURE D

rent of electricity is caused to flow around through the circuit as indicated by the arrows and the spark shown jumping the gap in Figure B. This current is instantaneous and is shown as a positive impulse making up one half a cycle in Figure E.

We have learned that when a current is allowed to flow through a coil, a magnetic field is set up around the coil, which causes it to become an electromagnet with one end of a north polarity and the other end south, as shown at L in Figure B.

When the current has flowed through the circuit, the charges that were on the condenser C have become neutralized and therefore the current ceases. When this happens the magnetic field that has been set up around the coil L collapses; that is, the magnetic rings fall back on the surfaces of the wires and a peculiar effect is noticed; a voltage is induced in the coil which is positive in the direction that the current was running.

This means that the condenser C receives a reverse charge immediately after the current from the initial charge has ceased to flow.

This second charge places a positive potential on the bottom plate of the condenser and a negative charge on the top plate, (See Figure C). This charge is not as strong as the first charge, however, because there is some energy lost due to the fact that the current must overcome the resistance of the wire and that of the air through which the spark must be forced.

When this second charge on the condenser reaches a high enough value to again break down the spark gap, a spark occurs across the gap and a second current flows through the circuit, in the opposite direction to the first current (See Figure D). This current forms a negative impulse which is shown in the diagram, Figure E, as the second impulse of the first cycle. Again the coil sets up a magnetic field around itself, only this time the top of the coil is of a south polarity and the bottom of the coil is north.

When this field collapses at the cessation of the second current the coil induces the third charge on the condenser which is in the same direction as the original charge.

The same cycle of events then takes place and the current oscillates back and forth through the circuit one way and then the other, but the successive oscillations become weaker and weaker until they die out (See Figure E).

Remember, however, that in our study of these oscillations we have considered them as slow oscillations; in reality they take place in the twinkling of an eye—much faster in fact. One of these series of current wave trains, as they are called, would look to the human eye, like one single crackling spark across the gap. The modern radio transmitter uses frequencies up to 2,500,000 cycles a second, which means 5,000,000 reversing impulses a second, jumping the gap. Little wonder that they look like one single spark!

We now have a general idea of how this simple little circuit, composed of these simple instruments, can perform this miracle of electrical speed and motion without any mechanical moving parts. Now we shall see how we can control the frequency of these generated impulses, by varying either the size of the coil or the size of the condenser.

We may liken the condenser to a pitcher of water. We know that if we have a small pitcher, a certain sized stream of water will require a certain length of time to fill the pitcher. If we use a larger size of pitcher, and hold it under the same stream of water, it will take a greater length of time to fill it. It will also take a longer time to empty the larger pitcher than it will take to empty the small one.

We can also liken the coil to a coiled tube that we can pour the pitcher of water into. A certain length of time will be needed for the water to wind around through the convolutions of the coiled tube and finally find its way out of the bottom. If we make the tube twice as long, it will take twice as long for the water to run through.

Now apply this idea to the electrical circuit. If we use a larger condenser C, it will take longer for it to charge and discharge, making the currents that oscillate through the circuit to last longer. If they last longer, there cannot be as many each second. Therefore if we increase the capacity of the condenser we get fewer impulses a second, thus decreasing the frequency of the oscillations and increasing the wavelength that is emitted from the antenna to which this circuit is coupled.

Or we may get the same result by increasing the number of turns of wire in the coil, and the current will take longer to run through it, so to speak; again we have less impulses a second or a higher wavelength. Increasing either the capacity of the condenser or the inductance of the coil, increases the wavelength. This latter method is generally used for transmitting stations, as it does not vary the power of the set to such a great extent while changing the wavelength, as varying the size of the condenser varies the power greatly that the circuit uses. A given size of condenser will hold a given charge, and if it is varied in size the charge varies in size also.

The coils are generally made with a large number of turns of heavy wire on them and a sliding contact slides over the surface of the wire and picks out the desired number of turns to be left in the circuit to obtain a frequency that corresponds to the desired wavelength.

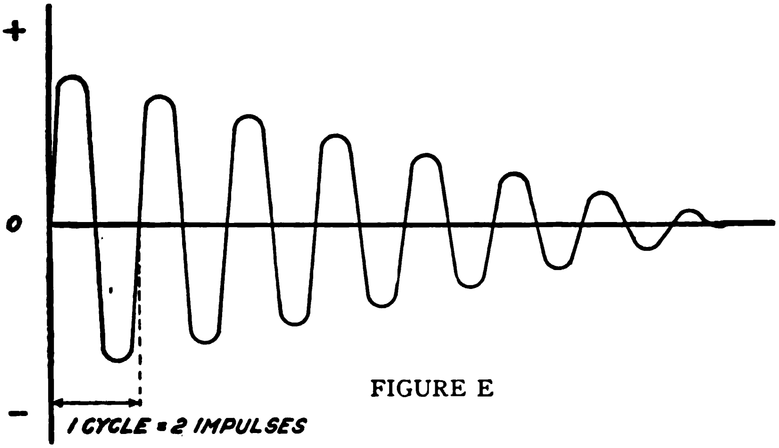


FIGURE E

In this way radio transmitting stations are tuned to the wavelength that they are required to send out on by governmental regulation.

So we find that the whole scheme is, after all, simple. The only feature that made it seem mysterious was the fact that we had no way of telling just what took place when the sparks "jumped the gap," until we analyzed the whole process.

In a future article we will show how these impulses are transferred to the transmitting antenna; then we will see that the coil plays a double role in the radio circuit.

Pointers for Preventing Interference

By C. A. BRIGGS

AMATEURS who operate radio sets for receiving music should tune and stop their bulbs from oscillating as quickly as possible, or they may interfere with their neighbor's entertainment.

When the bulb of a receiving set is oscillating it generates a high frequency alternating current. In this condition it constitutes a small transmitting station which may send out waves sufficiently strong to be picked up by other receiving apparatus in the vicinity. Indeed, communication may sometimes be carried on over short distances by utilizing this very fact.

While listening in on music, lectures and other broadcasted entertainment the amateur sometimes hears a smooth, whistling note that changes its pitch. As many as three such interferences have been heard at one time at a station. These sounds may be caused by nearby listening stations which are picking up the telephone wave and adjusting it in. Telephone waves are best picked up by starting the detector bulb to oscillating and then hunting about over different wavelengths until the whistle or squeal of the radio wave so familiar to radio operators is found. The different adjustments are then arranged to bring the response to the point of maximum efficiency; the final setting is generally such that the receiving tube is just on the point of, but not quite, oscillating.

Sometimes the telephone waves are received while the tube is kept oscillating; in that case the sounds may be loud but somewhat distorted and broken up.

For receiving code signals on continuous wave transmission it is necessary to have the receiving set oscillating, as the whistling note is the signal received. In such cases interference by other receiving sets may not be so serious. The quality of the sound is not important and the effect of the interference of receiving stations will not break up the dots and dashes of the code but merely add a continuous note to the intermittent notes that come from the distant station. An operator may sometimes stop his own tube from oscillating yet receive the incoming code signals with the aid of his neighbor's oscillating tube. This method, however, is not recommended as the other operator is sure to change his adjustments and lose the signal at a critical time.

The type of set known as the "single tuner circuits" are generally credited with being the worst offenders for producing interference. In these sets what constitutes the primary and secondary circuits of more complicated apparatus are in a sense combined, and the closer union of the tube circuit with the aerial is said to cause the set to radiate much more strongly than is otherwise the case.

It is well, therefore, for everybody who operates a radio receiving set to keep these tips in mind, and when he picks up telephone waves to make the necessary adjustments and stop the bulb from oscillating as promptly as he can.

The "Soup-Plate"

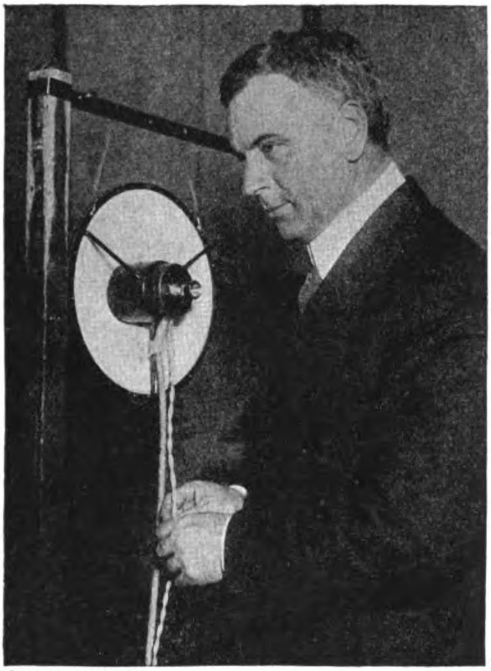
A Novel Type of Transmitter that Reverses the Principle of the Loud Speaker

By FREDERICK SIEMENS

THE problem of getting a large volume of sound converted into electricity for use in modulating the high-power transmitting stations that are now being used for radio broadcasting has become of increasing importance during the last year.

Several systems have been worked out to attain this result, but most of them have this serious disadvantage: while they produce a large amount of voice-controlled electricity, at the same time they distort the voice wave that is impressed upon them. Thus the reproduction is not as clear or as faithful as it should be.

One particular method that gives a very good quality of speech and relies upon the electromagnetic principle for its action is illustrated by the accompanying picture. The speaker or singer throws his voice into the "soup-plate" transmitter, as it has been nicknamed, which consists of a large paper diaphragm that vibrates in accordance with the voice wave that impinges upon it. The center of this diaphragm is attached to a moving coil which is placed in the magnetic field of a powerful electromagnet. When the diaphragm vibrates, the coil moves back and forth with it; this motion causes it to change its position in the magnetic field of the electromagnet. These motions of the coil back and forth, which conform with the voice waves, cause electric currents to flow in the coil which also are controlled by the voice waves. In this way the voice wave is changed from a sound wave into an electrical wave without depending on the old style transmitter which distorts so much and which uses carbon grains which are pressed tightly together or loosely as the voice causes them to vibrate.



© Keystone View Co.

Arthur Stringer, the well-known poet, recites his Irish poems by radio, from the broadcasting station at Fort Wood

The voice currents produced by the new method are remarkably true in following the complex voice vibrations as used by everybody in ordinary speech, and are remarkably effective in the reproduction of music. The current obtained from this instrument is magnified or amplified by means of vacuum tube amplifiers, somewhat similar to those used by the amateur, except that the tubes used are larger and are known as power amplifiers.

The cylindrical object that is shown, supported from the rim of the cone-shaped diaphragm by the three radial supports, contains the electromagnet and the moving coil.

The principle of the new transmitter is just exactly the reverse of the loudspeaker used for receiving. In the latter the electrical energy is converted into sound and in the transmitter the sound is converted into electrical energy. The same apparatus can be used for both purposes with slight modifications.

George Grantham Bain

An amateur who sings a copyrighted song by radio for the entertainment of fellow fans expects no financial returns from his efforts. But the use of such music by professional artists engaged by business houses is raising some knotty problems.

DOES BROADCASTING A SONG CONSTITUTE

"A Public Performance *for* Profit?"

If so "Who Will Pay the Piper"?—and How?—Ask the Music Publishers, Authors and Composers

By E. C. MILLS

DOES the singing of a song over the radio—more particularly the singing of a song of which the words and music are copyrighted—constitute a "public performance"? And if it does, is that performance "for profit"? And if it is for profit, who makes that profit and can the owner of the copyright collect payment for such a public performance?

These are only some of the questions that the amazing development of the radio and the extension of broadcasting programs have raised so suddenly that the song-writers and publishers have scarcely had time to determine just how their legal rights as well as their pocket books are being affected. According to the opinion recently rendered by Nathan Burkan of the American Society of Composers, Authors and Publishers, the singing of a copyrighted song by radio does in effect constitute a public performance for profit, and the owners of the copyright are entitled to revenue therefrom. Just how royalties may be collected, however, has not yet been determined.

A copyright on a song (or on any musical composition) vests in its proprietor three distinct rights:

(1) The right to print and multiply printings of the work;

(2) The right to control the mechan-

ical reproduction thereof (such as phonograph records and player-piano rolls), and

(3) The right to publicly perform or license the public performance (for profit) of the copyrighted work.

All of these rights are exclusive.

These rights are based upon the Copyright Act of 1909; it and the preceding Acts granting Copyright having been enacted pursuant to a clause in the original Constitution of the United States which provides that Congress should have the power, for the encouragement of the arts and sciences, to enact such legislation. The broadcasting by radio of concerts, for the entertainment of thousands (and soon, apparently millions) of owners of receiving apparatus, is, in the opinion of the authors, composers and publishers, a public performance for profit.

It is true that the listeners-in on these concerts do not pay to the broadcasting stations any fee for the service; nor does it seem immediately practicable to arrange any basis upon which broadcasting stations might charge a fee to the owners of receiving apparatus.

If broadcasting is to be continued however, it is obvious that it must pay commercial profits to those who operate the stations. Under the present conditions these profits must flow from the sale of receiving sets. If broadcasting does not pay as a commercial enterprise, it will be discontinued. As an alternative, it may be supported by the municipal, state or Federal governments.

If broadcasting pays as a commercial venture of a private concern, and the broadcasting of copyrighted musical compositions constitutes a part of its service, then obviously the music that is being used for purposes of profit and those who create such music are entitled to share in such profits.

Radio has developed in such an amazing and spectacular manner that it promises to become the greatest factor the world has ever known for the dissemination of information and education of the whole people. The position of musical copyright proprietors, including authors, composers and publishers, is now and will be in the future to lend their support to any cause or purpose which promises so much for mankind's benefit, and they therefore do not oppose radio, nor would they handicap or hamper its logical development.

HOW CAN THE RADIO PROFIT THE COMPOSER?

"The widespread use of music in broadcasting," states the author (who is the chairman of the Executive Board of the Music Publishers' Protective Association), "is materially decreasing the earnings of authors and publishers." What can they do about it?

On the other hand, the widespread use of music in broadcasting is bound to affect the earnings of the authors and publishers, it is even now decreasing them materially and promises to do so to a much greater extent. Fair and just recognition of the music writers of the country will make it necessary that they be reimbursed in some way by the radio which at present is reducing their earnings.

A basis for the charging of royalties upon such copyrighted music as is used in these broadcasted concerts has not yet been worked out. The copyright owners have felt that they should not place any obstacle in the way of the development of this art which promises so much. But in due course a plan for charging the broadcasting stations for the use of the product from which they derive their profit will presumably be worked out.

If the contention of the music publishers that the broadcasting of copyright music in the prevalent manner is a "public performance for profit" is correct, then a technical infringement of copyright is committed every time such a composition is broadcasted without a license from the copyright proprietor. The publishers are in communication with the various broadcasting station proprietors, and have every reason to believe that their position in the matter is one of entire fairness, and that they will frankly recognize the rights of copyright proprietors in this matter and work out a plan of compensation on a fair basis.

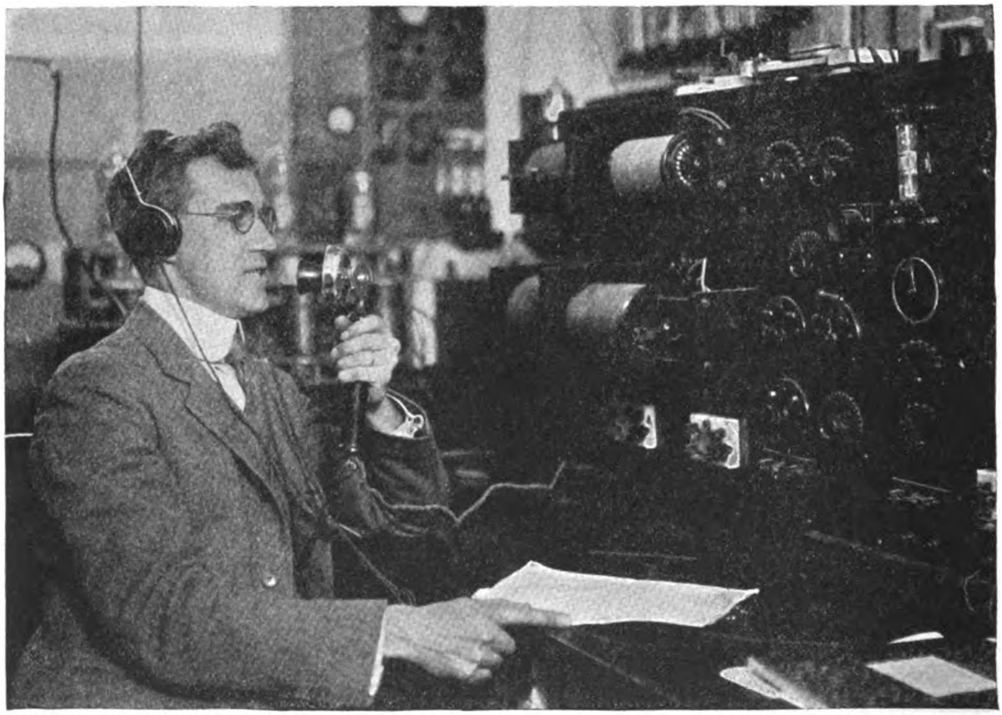


Photo by A. M. Vinje

A UNIVERSITY PROFESSOR LECTURES TO THE WHOLE MIDDLE WEST

On the principle that the citizens of the State of Wisconsin who support the University of Wisconsin are entitled to such privileges as the institution can extend to them, the officers of the university are carrying on "certain forms of extra-mural teaching" by means of radio broadcasting. This picture shows Prof. Alfred B. Haake delivering a talk on economics. Some of the lectures have been heard as far west as the Rockies and as far east as New England.

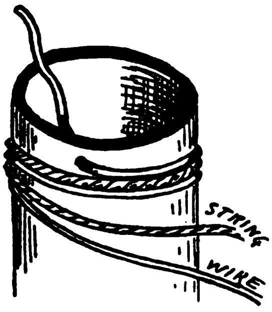


FIGURE 1

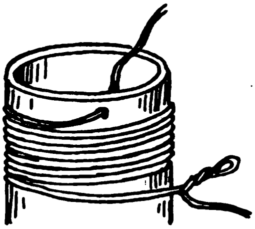


FIGURE 2

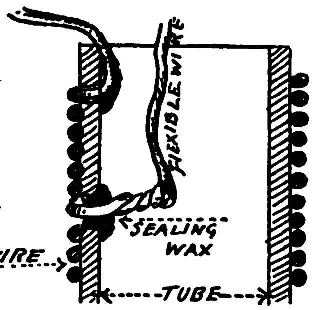


FIGURE 3

Illustrated with pen-and-ink sketches by the author from a home-made apparatus which he built himself

How *to* Make a Loose Coupler Coil

Another of the Practical and Popular "How to Make" Series of Articles for the Radio Novice

By A. HYATT VERRILL

ALTHOUGH vario-couplers, variometers and other instruments have largely taken the place of the older and simpler loose-coupled tuning coils, especially in the more expensive and ready-made sets, still, a well-made, loose-coupled coil is a useful device and will give excellent results. Moreover, it is far easier to make a loose-coupler than other forms of vario-coupler tuners; any one with the least mechanical ability and a little patience may build an efficient coil of this sort at a small cost.

No expensive or special tools are required with the exception of some twist drills, either used in a geared breast drill or a bit-brace, and the only materials needed are some formica or other composition tubes, some half-inch wood, wire, a few binding posts, a multiple point switch, half a dozen 1/8-inch by 1-inch brass machine screws with nuts and washers to fit, a piece of 1/4-inch round brass rod about 18 inches long, a piece of 1/4-inch square brass rod a little more than a foot in length, a small strip of spring brass and a piece of square brass tubing 1/4-inch inside and 2 inches long. Formica or other composition tubes are suggested; while pasteboard tubes or wooden cylinders may be used as the foundations for coils, they are not advisable. They do well for experimental work or rigging up a temporary set, but even if shellacked or soaked in paraffine they will still absorb moisture, and this detracts from the efficiency of the coil. In our climate, where the air is damp and humid in summer and the houses that are heated by artificial means are dry in winter, wood and cardboard will swell, shrink or warp and eventually ruin the coil. Accordingly, if you intend to make a good coil, get tubes that will serve you well and will endure; good work is worthy of good foundations.

The exact size of the coils is not important as long as the diameter of the smaller one is a trifle less than the diameter of the outside coil, so that it may be slipped within and yet leave at least 1/8-inch all around. If the larger tube is between 2½ and 3½ inches in diameter and from 6 to 8 inches long, it will do very well and the smaller tube should be the same length.

The first step is to wind the larger or primary coil. This may be done either with double cotton covered, enameled or bare copper wire about No. 24 in size. Make a small hole about three-fourths of an inch from each end of the tube; thread about 6 inches of the wire through this and fasten the wire on the inner side of the tube with a drop of sealing wax. Then wind the wire on smoothly and evenly. If you are using insulated wire, merely wind on the turns side by side, but if you are using bare wire wind it on with a cotton string or twine between each turn of wire, as shown in Figure 1.

When you reach the hole at the opposite end of the tube, run the wire through, fasten it inside the tube with sealing wax and snip it off close.

When you wind a tube, you will find it far easier for two to work than to do it alone. One can then hold the coil as the wire is wound on while the other can unroll the wire and keep it free from kinks. If you buy a reel or spool of wire this may be hung up on a nail or peg and may be reeled off easily without fear of kinking. Also, if you have a lathe you will find it very easy to attach the tube to the lathe and by revolving the tube wind the wire on easily and smoothly. To fasten the tube in the lathe, slip it over a cylindrical piece of wood, fasten it lightly by small screws through holes close to the ends of the tube and place the chucks against the wooden cylinder.

To wind the smaller or secondary coil is not a simple, for this must be tapped at intervals of every twenty turns. Start the wire in the same way as on the large coil and wind on twenty turns. Then, make a small loop or twist in the wire as shown in Figure 2. Scrape off the insulation and attach a piece of flexible insulated copper wire about a foot long. Make a good connection (keep the wires bright and twist them firmly together), and then, just where the tap comes on the tube, bore a hole, run the flexible wire through, pulling the loop in by gently pulling on the end of the flexible wire at the end of the tube and drop a bit of sealing wax upon the wire where it enters the hole (Figure 3). The only care needed in doing this is to have the hole large enough to allow the tap to pass through freely, to be careful and not kink the wire on the outside of the coil and to hold the wire wound on the coil in place while making the tap and pulling it through the hole. You may have a bit of trouble with the first tap, but if anything goes wrong you can unwind the first twenty turns and start over again without much trouble—and it is a good plan to become adept and to make a neat job of this first tap before continuing to the next.

After the first tap is made the others will be easier, for by carefully measuring the distance from the first turn of wire on the tube to the hole for the tap you can measure off the spaces on the tube for the other taps and make the holes ahead of time. After the first tap is successfully made, continue winding for the next twenty turns, make a second tap the same way and so on to the end of the coil, where the wire should be run through a hole, fastened on the inside of the coil with sealing wax and left with about a foot of loose wire free.

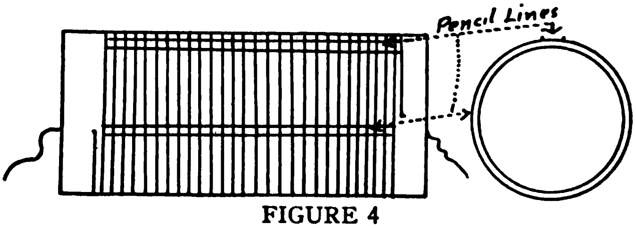


FIGURE 4

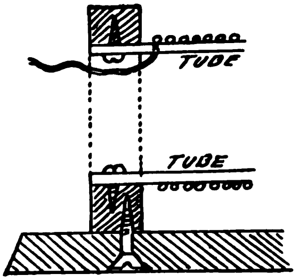
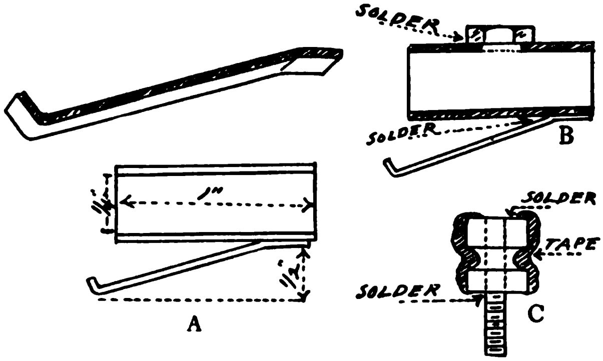


FIGURE 5



FIGURES 6, 6A, 6B AND 6C

The next step is to mount the coils. Use either Bakelite, fibre or well-seasoned white wood for this. If you have a jig-saw or a small keyhole saw, you can readily do everything yourself, but if not you can get some nearby carpenter or cabinet maker to cut the pieces for you. Assuming the large coil is 3 inches in diameter and 7 inches long, you will require a rectangular piece 5 by 15 inches for the base or panel; two pieces 4 by 4 inches for the primary or large coil support; two pieces 3 by 3 inches for the supports for the secondary or smaller coil and two circular pieces or discs just the right size to fit snugly into the smaller tube.

The two pieces 4 by 4 inches to support the primary coil should have circles or holes cut in each; the circles should be just large enough to admit the bare ends of the large coil. Have all these pieces of wood smoothed and sandpapered, bevel the edges of the square and rectangular pieces and give them a coat of stain and let them dry. Then sandpaper again, give another coat of stain and when dry give two coats of valspar varnish or shellac. While the stain or varnish is drying you can go on with the other parts of the loose-coupler. Along the large coil (if wound with insulated wire) mark two lines ¼-inch apart as shown in Figure 4, using a ruler to get them straight. Be sure that they are true and parallel with the axis of the coil. At 90 degrees from these, or at one side if the first lines are uppermost, draw two more lines parallel with the first. Then, with a red-hot iron, burn off the insulation along these two marks between the pencil marks, ¼-inch apart. If the wire is cotton covered you may overcome any tendency of the cotton to

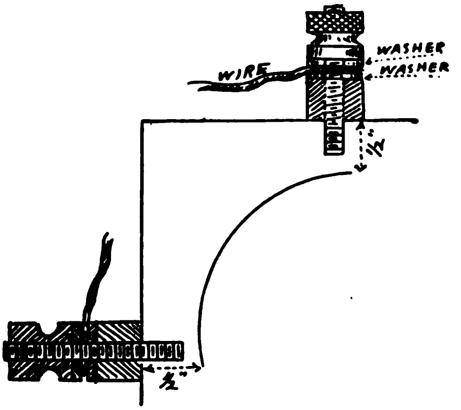


FIGURE 7

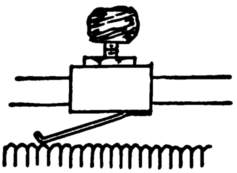


FIGURE 7A

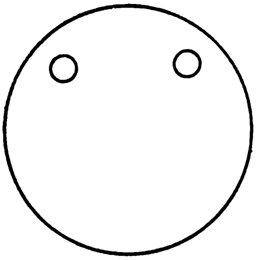


FIGURE 8A

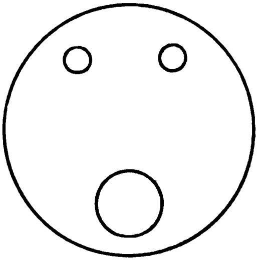


FIGURE 8B

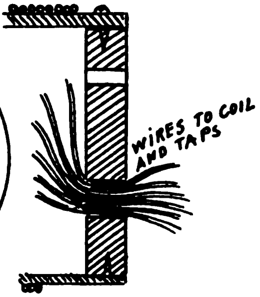


FIGURE 8C

burn irregularly from the lines by running a damp rag along the lines, or you may clean off the insulation with a sharp knife. However you do it, clean the wires until bright; if by any chance they bend or slip together, wind a string between the turns. If you have used bare wire, this burning off of the insulation will of course be unnecessary and for that reason I advise using bare wire and keeping the turns separated by twine, which may be removed after the coil is wound, although it does no harm if left there.

The coil may then be mounted by attaching it to the uprights by small screws driven through the bare end of the coil into one upright piece, as shown in Figure 5. This upright should be attached to the base, the coil fastened to it and the other upright slipped over the opposite end of the coil and fastened to the base but not to the coil. If holes are bored in the proper places through the base and into the upright before slipping it on the coil, there will be no trouble in securing it in position.

Next, cut two sections of the square brass tubing, each 1 inch in length and cut two strips of spring brass about ⅜ of an inch wide and 1/32-inch thick and bend in the form shown in Figure 6. Solder one end of each to each of the sections of square tubing as shown in Figure 6A. Bore a hole, a trifle more than ⅛-inch in diameter, through the opposite side of each section of brass tubing and over each solder a brass nut to fit the ⅛-inch brass screws. The easiest way to do this is to clamp the tube in a vise, fit a wooden pin through the nut, insert the end of the peg in the hole in the tube and while holding the nut in position solder it, as shown in Figure 6B. Then, cut the heads from two of the ⅛-inch brass screws, leaving about ¾ of an inch of the threaded shank, screw a thumb nut or knurled nut, such as you may obtain from an old dry battery, on the screw and solder it. Smooth off the solder and any projecting parts of the screw above the thumb nut with a file and wrap a little adhesive tape around the thumb-nut. (Figure 6C.)

Now slip a piece of the square brass rod through one of the sections of brass

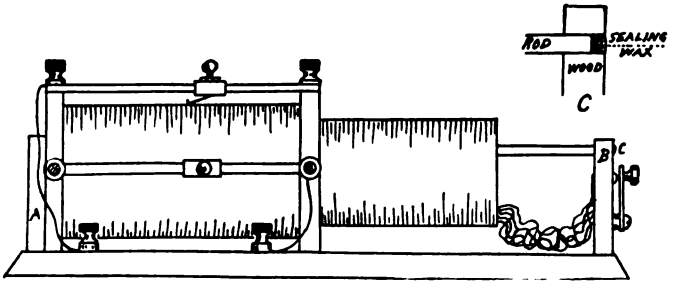


FIGURE 9 AND 9C

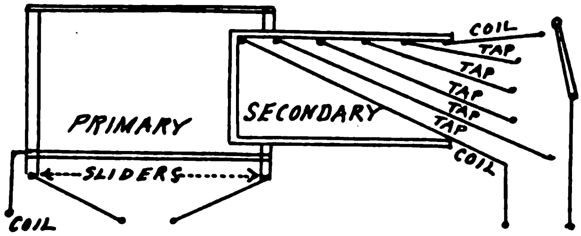


FIGURE 10

tube and lay the rod along the coil from one upright to another over the bared space on the coil wires (if they are insulated wires); when it is exactly parallel with the bared space (or with the coil if bare wire has been used), mark with a pencil where the rod comes on the uprights and cut the rod to the right length to come even with the outer edges of the uprights. Bore a ⅛-inch hole through each end of the rod, make a slightly smaller hole in the uprights under the holes in the rod, and screw one of the ⅛-inch screws into each of these. Clip off the heads of the screws, slip the rod over them, place a washer on each screw and secure the rod by means of a binding nut as shown in Figure 7, first placing a wire terminal under the washer on one screw. If you have done all this according to directions the spring on the under side of the slider should bear firmly against the wires on the coil. Then,, by screwing the brass screw with the thumbnut soldered upon it (Figure 6C), into the nut soldered to the slider you can secure the slider in any position and can move it back and forth by means of the tape-covered nut as shown in Figure 7A.

The other slider should be mounted on its rod on the uprights in exactly the same manner, but over the other bared space of the coil (or, if bare wires are used, on one side of the support parallel with the axis of the coil.

The next step is to mount the secondary or inner coil. This is done by first securing the two circular pieces of wood in a vise or clamp and boring two holes ¼-inch in diameter through both pieces a little above their center, as shown in Figure 8A. Bore another hole, large enough to admit all the tap wires and the two ends of the coil wires, through one of the wooden discs (Figure 8BC). Secure this disc in one end of the coil (first drawing the wires through the hole made for them), by small screws driven through the bare ends of the tube, as shown in Figure 8C. Then place the other disc in the other end of the tube and by sighting through the ¼-inch holes align it with the first one. It may help you to do this if you draw pencil lines along the coil, parallel with the axis, from the two holes in the first disc; it is highly important to have the holes in the discs come in perfect alignment, as otherwise your coil will not move evenly and truly on its rods after it is assembled.

When the second disc is in the right position, secure it as you did the first by small screws. Then slip the ¼-inch brass rods through the holes in the discs and wrap the coil smoothly with heavy paper, wrapping the paper on until the coil fits snugly inside the larger coil without forcing it. Rub some chalk or crayon on the ends of the rods that run through the small coil and while holding one of the 3 by 3 inch pieces of wood against the support to the large coil, press the two rods against it and turn them about until the chalk has marked spots where the rods touch. Then, clamp the two pieces of 3 by 3 inch wood together with edges even and bore ¼-inch holes through both where the chalk marks show. Slip the pieces over the rods and secure them to the base. Fasten one at the end of the large coil and the other near the opposite end of the base (Figure 9AB'). Remove the rods and the small coil. Remove the paper wrapping from the coil and holding the coil in front of the large coil, slip the rods through one upright, through the two end discs in the coil and through the other upright. Cut the rods so that they are not quite flush with the outer sides of their supports and secure them in place with sealing wax as shown in Figure 9C.

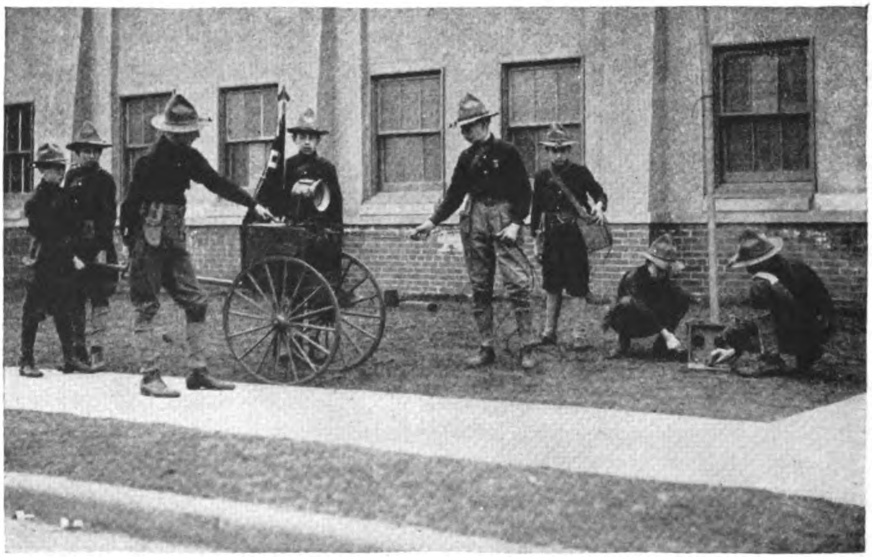
All that now remains to be done is to connect the various wires. Each of the tap wires and one of the end wires of the small coil should be carried to a separate contact on a multiple point switch which is best mounted on the upright as shown in Figures 9 and 10. If you prefer, you may place the switch on the end disc of the coil itself, but I have found this a bad plan, as in adjusting the switch you invariably move the coil somewhat.

The coil should move freely but not loosely. The other end of the coil wire should be led to a binding post; another wire should connect the switch arm to a second binding post and the free end of the wire from the large coil and the two wires from the slider rods should be led to other posts, all of which is shown in Figures 9 and 10.

Always remember to wind both coils in the same direction, to use flexible wire for the tap and coil leads on the secondary coil and be careful and accurate in your work.

Do *not* shellac the coils after winding and *never* use paint or enamel varnish about the coils or wires. Countersink all screw heads in the wood, leave no rough ends or jagged edges to metal or wood and try to make the finished coil a credit to your skill and to your workmanship.

¶ *The next article of this series will tell you how to make your own variable condenser at about half the cost of the ready-made devices which are on the market—but which are now so hard to find.*



WHAT THE BOY SCOUTS ARE DOING WITH RADIO

More than any other discovery or invention of recent times, the radio has entered into the activities of the largest and one of the most valuable organizations of boys in the world. How these scouts are making themselves proficient in this art, and how they are learning to use the radio in practical ways, will be told in an article by Armstrong Perry—in a near issue of POPULAR RADIO.

The Best Ground *for* Small Antennae

By S. R. WINTERS

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The lowest radiation resistance ever recorded in this country has just been attained by the use of a counterpoise ground system—a new development that makes extensive savings in electrical energy.

ON the theory that when a counterpoise is used with an antenna only low electrical resistances are possible, a series of experiments conducted by Dr. J. M. Miller of the Radio Research Laboratory, Bureau of Engineering, United States Navy Department, has abundantly justified the original conception. Measurements taken while the investigation was in progress revealed a surprisingly low minimum antenna resistance for a small antenna of 1.4 ohms, at 800 meters, and a ground and conductor opposition of only 0.7 ohms.

Novel experiments require unusual equipment. The experimental antenna was constructed near Connecticut Avenue in Washington, D. C., at a point where a slight rise in the elevation of the earth partly obscures from the view of passers-by, the physical equipment of the National Bureau of Standards, located on a commanding hilltop. Here on a vacant lot, with the nearest trees a hundred feet distant and an area unobstructed save by weeds struggling for existence, the masts of the radio installation tower skyward. These upright steel poles, fifty feet high, are three in number, and form a triangle, with a distance of a hundred feet to each side. The soil may be wealthy in humus for producing crops but is not at all favorable to the installation of equipment essential to transmission of wireless messages. Six inches below the surface of the ground, rock was struck, but the geological formation, fortunately, was pliable enough to yield to the blows of a pick.

The antenna was built in the shape of a triangle with radial wires attached at a center point, the wire was copper, No. 10, tautly drawn and insulated from the triangular-grouped masts by three 24-inch porcelain rod insulators. Originally each mast was insulated by three glass ball insulators placed under the foot and supported by nine guys, each of which was insulated near the ground by a porcelain egg insulator. The lead-in consists of a six-wire 12-inch cage of No. 16 wire. A buried ground system and a counterpoise were both investigated. The ground system embodies a circular trench, two feet deep and twenty feet in radius, circumventing the bottom of the lead-in circuit. Seventeen galvanized iron plates, two feet wide, were set on edge around the trench, overlapping each other by a margin of a few inches. One insulated wire is attached to each plate and retraces its course to the foot of the lead-in along the surface of the ground. A recent British publication favors a suspension of these wires above the earth, but experimenters in this country are not so positive as to the necessity of the English recommendation.

When the equipment was completed it was subjected to resistance measurements by the radio experts of the Radio Research Laboratory of the Navy Department, which is under the direction of Dr. L. W. Austin. During the first two or three days the electrical resistance of the ground conductor appeared to be declining; after four days a curve was plotted to show the exact ratio of the decreasing radiation resistance, a factor in the interest of efficiency. The antenna capacity was 700 micro-microfarads. The resistance curve indicated a ground and conductor resistance of approximately 2.5 ohms. Taking into account the unfavorable soil and the dimensions of the ground system, the results were pronounced extremely gratifying. The dielectric losses, however, proved excessive and further curtailment of this loss was sought. The masts and guy insulators were held responsible for a major portion of these losses.

Subsequently an antenna resistance curve was obtained with the upright poles and guys grounded. A substantial reduction of dielectric wastage was thus achieved. Measurements were then made on one of the mast and guy systems used as an antenna, and excessive dielectric loss was evident. At this juncture, modifications were made in the insulating equipment; porcelain insulators displaced glass under the masts and a notable reduction in dielectric losses was vouchsafed when the nine porcelain egg insulators in the guys were displaced by three 24-inch porcelain rod insulators. Porcelain rod insulators were also used in the counterpoise and as the capacity was small, low dielectric wastage was effected—a feat attributed to these rolling-pin like insulators.

As a second chapter of the investigations inquiring into the reasons for the existence of comparatively high electrical resistances of radio antenna and ground equipment, the Radio Research Laboratory of the Navy Department installed a counterpoise for use in measurements. The design was insulated from the supporting stakes by 30-inch porcelain rod insulators, the counterpoise having a radius of approximately 55 feet and a height above the ground of three feet. Its capacity to the ground was 2,100 micro-microfarads. The measurements is determining the resistance gave surprising results; the minimum opposition of the antenna was 1.4 ohms, at 800 meters wavelength, and only 2.1 ohms at 2,000 meters. The ground and conductor resistance was 0.7 ohms. Employing the circular ground system, previously described, the corresponding value for ground and conductor resistance was 2.5 ohms.

"Considering the fact that the circular ground had a radius of 20 feet as against 55 feet for the radius of the counterpoise" (to quote Dr. J. M. Miller, radio aide of the Bureau of Steam Engineering of the United States Navy Department), "it is believed that a ground system of the same radius would not be greatly inferior to the counterpoise electrically, and very much better from a practical standpoint. It is hoped that there will be an opportunity to try out the experiments on a larger scale. Everything favors proportionately low resistances as the size of the antenna and ground system is increased. The actual ground resistance should decrease nearly in proportion to the radius of the ground system. The resistance due to dielectric loss should also decrease rapidly as the capacity of the antenna increases."

Low electrical resistance in the functioning of shore-station antenna — the primary object of this investigation—is in the interest of increased efficiency in the radiation of electro-magnetic waves. At present power is supplied the antenna and a portion of the power is usefully consumed in the radiation of waves. The remainder of the power, however, is needlessly squandered in ground and dielectric resistances. The lower these useless losses are reduced the more efficient the antenna becomes. Then, too, when the radiation resistance is at a minimum it requires less current for an antenna of specified resistance to obtain a given efficiency. High-powered radio stations realize the importance of a reduction of electrical resistance. On board ships, the problem is that of a curtailment of dielectric losses rather than a search for efficient ground connections. The latter condition is ever present on seafaring vessels. There are three different resistance components in the functioning of an antenna; the true radiation resistance is the only useful one. The other two—ground resistance and dielectric losses—are useless. Efficiency demands that they be reduced to as low a value as possible.

The results of the experiments described conclude that if the current flow in the ground is not restricted a low resistance is effected. A counterpoise covers a comparatively wide area, has a high electrical capacity to ground, and there is no concentration of current; hence the resistance is low.

Another conclusion deduced by this investigation is that in the present ground systems much of the conductor planted in the soil is useless. There is a tendency for the current to flow off the ground wires through the soil. The ground connections employed in this experimental equipment hearkens back to a system originated by Capt. Round called the "round" ground. The metal plates are set on edge in a circle in the soil around the foot of the lead-in. The insulated conductors from the circular ground are brought out above the surface of the earth, and are joined together at the foot of the lead-in. The area is effectively used—the current flow over each square

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The wires that radiate from the common center connection under the table form one plate of a large air condenser; the ground is the other plate.

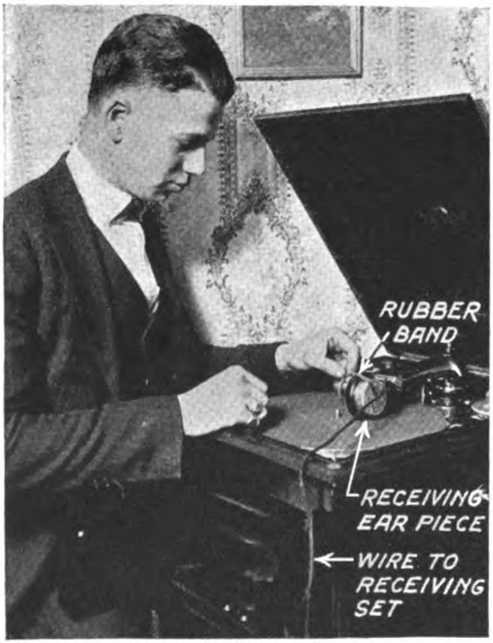
foot being about the same as every foot of buried conductor. To avoid dielectric losses the antenna was established at a considerable distance from trees and buildings. Insulators were used in both antenna and counterpoise. The symmetrical antenna with the ground system is most effectual for use with the "round" ground.

How well this experimental antenna has lent itself to the reduction of resistance—the remarkable accomplishment of 1.4 ohms at 800 meters wavelength with a small antenna—may be illustrated by the following comparisons: an extreme example is that of the portable military antenna, that has a resistance as high as 120 ohms. The average small good antenna has a resistance ranging from 6 to 8 ohms. Only the enormous high-power stations have succeeded in curtailing opposition to a minimum of 1 or 2 ohms.

How to Use Your Phonograph As a Loud Speaker

By FRED WOODWARD

AFTER one has been operating for a time a radiophone receiver equipped only with telephone receivers, one is overcome with the desire to possess a loud-speaking horn in order that he may entertain more people at one time with the music he receives from the broadcasting stations. Here is a way to hook up your radiophone to your phonograph and save yourself the expense of purchasing an amplifying horn:



From a photograph made for POPULAR RADIO

Take the reproducer off the tone-arm of the gramophone. In most talking machines this may be easily done by the removal of one small screw. This leaves two small holes at the end of the tone-arm. Then place the receiving ear piece over each of the holes at the end of the tone-arm, and fasten them in place with a stout rubber band.

Then throw on the aerial switch and tune-in for whatever you wish to receive—music, news or signals. You will be surprised with the result. The gramophone cabinet, as you know, is the sound-box of the machine. When you have hitched up the telephone receivers of your radiophone to the tone arm of the gramophone you will discover that the box does for the radiophone exactly what it does for the gramophone record and reproducer: it amplifies, or magnifies, every sound that it receives.

If your radiophone is in anything like working order the music will be easily heard all over the room. It will allow you to have your friends listen to incoming signals without the necessity of getting additional apparatus. It will amplify radiophone music to such a degree that it may even be used for dancing.

This trick cannot be done with a crystal receiving set. It is necessary to have at least a one or two-step audio frequency amplifier.

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department; it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many ot these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: I would like to put up a radio set of my own, but there are no poles or trees near my home. Can I put up the antenna from the fire escape to the other window? The length of the antenna would then be about 15 feet. Would I then be able to hear distinctly? Is lead-in wire the same as copper wire No. 14 insulated or bare?

L. A. W.

ANSWER: The antenna you suggest would be far too short. You should have at least one wire 100 feet long for the best results. You will hear signals weakly at best with the 15 foot antenna. The lead-in wire may be No. 14 copper either insulated or bare. If bare wire is used for the lead-in, it should be mounted on insulators.

* * *

QUESTION: Will you tell me how to eliminate the noise in a 2-step audio frequency amplifier that works all right otherwise? I am using the hook-up advised by the makers of Radiotron tubes and am using these tubes throughout, with a Radio Corporation transformer in the first step and a Federal transformer in the second step. Common 45-volt "B" battery is used for detector and amplifier with suitable taps. All wiring is bus bar type, soldered and insulated, with minimum parallelism. Transformers are placed between the tubes. Will a storage "B" battery eliminate the trouble? I am using a second Edison 6-volt storage battery for the "A" battery. Please give me a detailed hook-up to show all the apparatus necessary for one or more steps of radio frequency amplification.

W. R. PARTINGTON

ANSWER: One suggestion that may help is to ground the cores of the amplifying transformers. Another precaution against noises is to ground the negative terminal of the "B" battery. If the cells of the "B" battery get old they sometimes make "frying" noises. I recommend that you try the hook-up given in our June issue in this department. The storage "B" battery will not eliminate the noises unless your present "B" battery is the cause of the trouble, which could then be remedied just as well by replacement with new "B" batteries. In reply to your last request I am glad to refer you to an excellent article on radio frequency amplification to be published in a near issue of this magazine.

* * *

QUESTION: Will you send me a diagram for making up a set for receiving up to 1,500 meters? What would be the cost of such a set?

HANS J. POLL

ANSWER: In the May issue of this magazine (page 59) is given a hookup suitable for the purpose you desire. You should substitute for the three coils there given the three following coils which will give you the wavelengths you desire: Primary L-150, Secondary L-200, Tickler L-250.

* * *

QUESTION: I want to get a hook-up of a circuit for using crystal and audion detectors by merely throwing the switch. Can you give me one?

S. V. FINLY

ANSWER: You do not say whether you want to use this hookup with a single circuit tuner or a double circuit tuner. However, here is a circuit for a double circuit tuner, (Fig. 1) as this is the most efficient for tuning purposes. A single pole, double throw switch, will be required as shown connected in the diagram. To use the audion throw the switch to "A" and turn on the filament. To use the crystal detector throw the switch to "D" and turn off the filament of the audion and adjust the fine wire on the crystal detector.

QUESTION: My receiving set works all right, while I am sitting absolutely still, but if I so much as turn my head or move my arm or lean forward or backward, I hear crackling noises that nearly break my ear drums. I am using a Paragon receiver and two stage amplifier with Baldwin fones. Aside from this peculiarity the set works well and I listen to Pittsburgh, Schenectady, Detroit, and a number of other long distance broadcasting stations. Can you offer any suggestions for a remedy?

GEO. B. HILL

ANSWER: The symptoms you have given indicate that the telephone cords are worn through and when you move your body the cords also move and the fine stranded wires make and break the connection, thus causing the series of clicks and crackling noises that bother you so much. Purchase a new set of telephone cords and replace the old ones on the headset and your troubles will be ended.

* * *

QUESTION: Please tell me what a good audion set will cost that will receive over a distance of 200 miles?

A. W. ROSE

ANSWER: This set should include a detector and two-stage amplifier of the vacuum tube type. It will cost slightly over $200.00 complete.

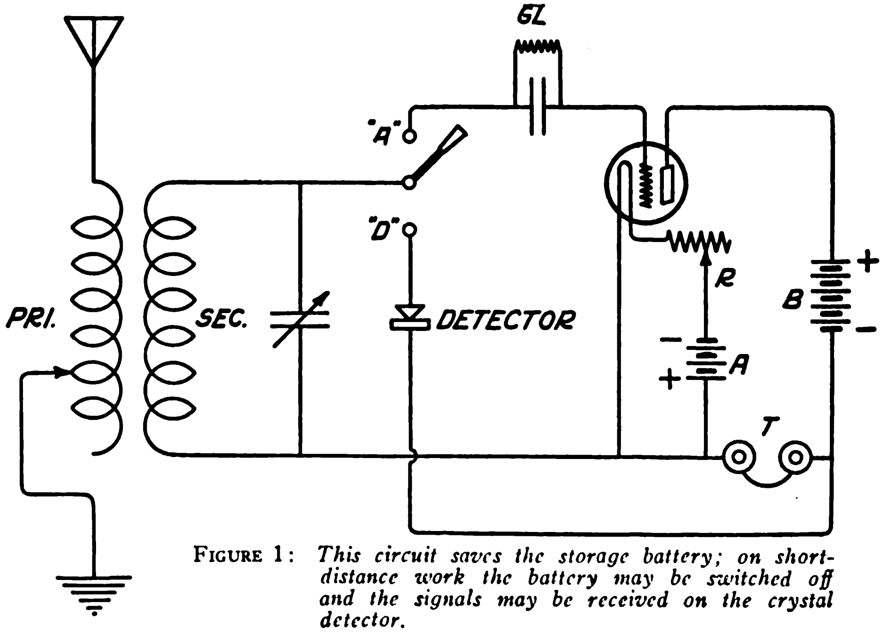


FIGURE 1: *This circuit saves the storage battery; on short-distance work the battery may be switched off and the signals may be received on the crystal detector.*

QUESTION: How far can I receive on a crystal detector and a slide coil? I have just put up a one wire aerial 150 feet long and 35 feet high. The aerial has a little slant; does that matter?

ALBERT MUNN

ANSWER: A slight slant will change the electrical characteristics of the antenna a little, but it will not interfere with the strength of your signals. You should be able to receive up to a distance of twenty-five miles from the broadcasting stations.

* * *

QUESTION: A friend of mine who lives in the apartment below mine has become so interested in my receiving set that he has asked me to get him the necessary apparatus and help him to rig it up. I agreed to do so. Will I have to put up another aerial, or can we both use the same one?

A. PAGE

ANSWER: You will not get good results on either set if you connect both sets on to the same antenna. One set would absorb most of the energy and the other would get little, in accordance with the wavelengths that both sets may be tuned to. If both sets were to be tuned to exactly the same wavelength they would divide the current between them but signals of only half strength would be received by both. Use separate antennæ.

* * *

QUESTION: Is there any way to keep a crystal detector set in adjustment? I have trouble when I try to get it set because when there are no signals coming in I do not know whether it is in adjustment or not.

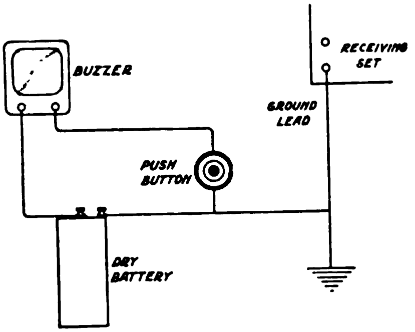


FIGURE 2: *A buzzer test for a crystal detector.*

ANSWER: You should build a buzzer test for this purpose. The instruments you will need for this are the following:

1. A buzzer such as is used for code practice.
2. A dry battery.
3. A push button switch.
4. A few feet of wire.

Connect these up, as shown in Figure 2, with one wire running over and connected to the ground lead of your receiving set. When you want to adjust the detector, press the button and adjust the contact on the detector until the sound of the buzzer is heard loudest in the telephones; then the detector will be in adjustment and you can tune around with the tuning instruments; if there are any stations transmitting at the time you will hear them. The buzzer acts as a miniature transmitting set.

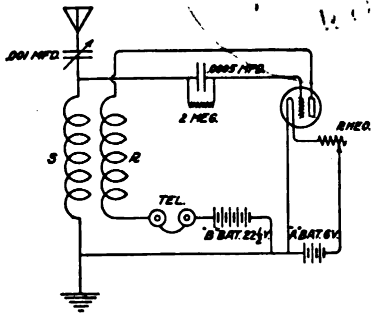


FIGURE 3: *A Hook-up for a single circuit regenerative receiver.*

* * *

QUESTION: Will you give me a hook-up for a single circuit regenerative receiver that employs an audion detector?

W. S. MITCHELL

ANSWER: The circuit described uses a variometer in which the stator has been disconnected from the rotor and the rotor placed in the plate circuit. A .001 mfd. condenser in series with the stator comprise the tuning elements. All tuning is done by revolving the variable condenser knob. The regeneration is accomplished by revolving the rotor of the variometer. (See Figure 3.)

* * *

QUESTION: What is the best kind of wire to use for an antenna?

D. W. JACKSON

ANSWER: The most efficient wire to use for an antenna is a copper wire with an enamel coating. The high frequency radio currents induced in an antenna travel on the surface of the wire. Ordinary copper wire oxidizes when strung up out in the weather, and the oxidization offers resistance to these currents. The enamel coating prevents the wire from becoming oxidized.

Question: Where can I get a wireless directory that gives all the calls of wireless stations, amateur, Government and commercial, which do transmitting in the United States.

B. W. Wheeler

Answer: Send 15 cents to the Government Printing Office and ask for a copy of the yearly "Amateur Radio Stations of the U. S."

* * *

Question: What is a loading coil used for? Will it help me to receive from greater distances than I now can get?

E. B. Ginn

Answer: A loading coil is used in series with a radio circuit to increase the wavelength range of the set. It will not, however, increase the distance range from which you can receive.

* * *

Question: I am using a well-known type of regenerative receiving set, but it howls and squeaks most distractingly. Is the set poorly designed or do you think that there is some connection loose?

L. J. H.

Answer: Most of the receivers on the market are of fairly good design and workmanship, and the trouble probably may be found in the way you tune it. You probably use too much regeneration while tuning; this causes a howling that may cover the whole scale of sounds from a shrill whistle to a low grunt. While tuning in a station, place the dial which controls the regeneration at zero; when you have the signals tuned in, slowly increase the regeneration until the signals are made strong enough without being distorted.

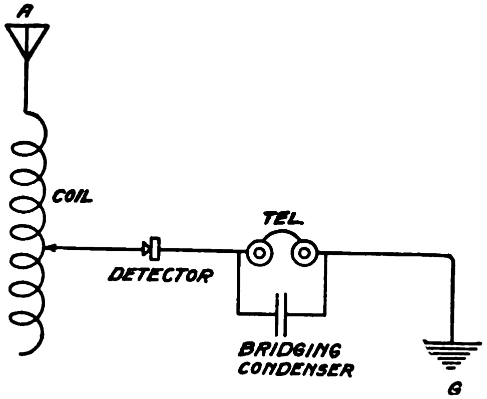


Figure 4: *A simple circuit for a crystal detector.*

Question: I want to build a simple crystal receiver. The simplest circuit you could give me would be the best, as this will be my first attempt at building a set.

Jos. Kenyon

Answer: The circuit shown in Figure 4 provides for a single slide tuning coil, a crystal detector, a small fixed bridging condenser, and a pair of receiving telephones. By adjusting the detector and moving the slider on the coil. different wavelength signals can be picked up. The range of this set is about 20 miles.

* * *

Question: What is the best detector to use in a radio receiver?

Wm. Hansen

Answer: The vacuum tube or audion is by far the most efficient. The crystal detector is cheaper and simpler to operate, but it will not detect distant messages or bring in signals as loud as the audion.

* * *

Question: What is the correct length of antenna to use in order to receive the radio broadcasting on 360 meters? My antenna is only 40 feet above the ground.

F. G. Ornerod

Answer: You should make your one wire antenna about 100 to 150 feet in length. Use as short a lead-in as possible.

* * *

Question: I have a quantity of fixture wire which I can strip of its rubber and braided covering, if it would be of any use. Will this wire be suitable or not? I do not want to do all this work only to find out that the wire is no good for such a purpose.

H. Barnes

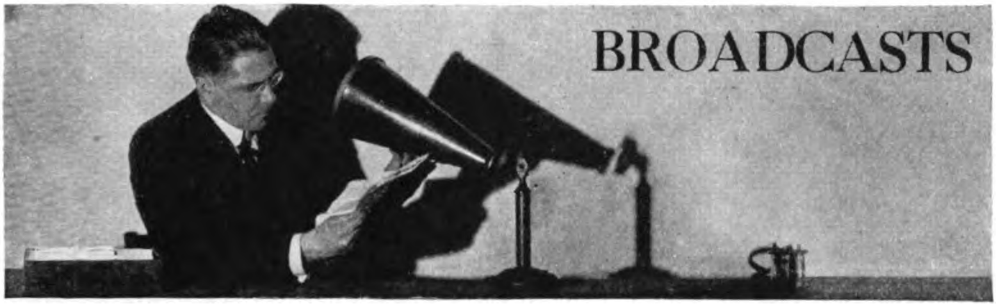
Answer: You may use the wire but you do not have to strip it of its insulated covering as it will work just as well with it as without it. The insulation does not affect the antenna in the least as far as functioning efficiently is concerned.

* * *

Question: What is the difference between a variable condenser and a variometer?

L. L. Romersheuser

Answer: A variable condenser is an electrical instrument for controlling the amount of capacity in a circuit. A variometer is an electrical instrument for controlling the amount of inductance in a circuit.



ITEMS *of general interest that you ought to know; bits of information of practical usefulness to every radio amateur.*

There Are Now 253 Broadcasting Stations

FIGURES obtained from the Department of Commerce show that there are 253 broadcasting stations now licensed and in operation. Most of these stations are concentrated either north of the Mason-Dixon line and west of the Mississippi or on the Pacific Coast. There are practically no stations as yet in that part of the west that lies just east of the Rockies. The installation of stations has only just begun in the South.

John Bull Begins to Take an Interest in Radio

PLANS are at last being made over in England to develop radio on a large scale—but along different lines from the recent expansion in America. Up to this time the Post Office Department has made the use of radio apparatus by private persons almost impossible, owing to the licensing system which applied both to receiving sets and to sending apparatus.

Now, however, steps are being taken to change this policy and to permit the extension of radio telephony.

As soon as restrictions are removed it is understood that the Marconi Company will establish a large transmitting station, and that receiving apparatus will be hired out at a charge which will probably not be more than that of the ordinary telephone installation. It is reported that the Marconi concern is ready to make innumerable fool-proof instruments that will be rented out.

English newspapers are only just beginning to explain to their readers the general features of radio telephony.

Radio Messages Received While the Operator Is Absent

A RADIO relay recorder that receives and copies messages without the use of a trained radio operator, operates mechanism automatically in accordance with the signal received and acts as an automatic call system has been perfected by F. W. Dunmore of the radio laboratory of the Bureau of Standards. It is sensitive enough to convert accurately feeble radio signals into records, yet will operate in a vibrating airplane.

"The practical operation of relays actuated by received radio signals is a comparatively recent development, and has been made possible by the development of the electron tube amplifier," says Mr. Dunmore. "The relay recorder is designed to operate from the output terminals of a radio receiving set; it may also be operated by any other source of audio-frequency signal. By the use of special electron tube circuits the audio-frequency signal is caused to operate an ordinary telegraph relay. In order to avoid the necessity for using a sensitive relay, designed to operate on currents of a milli-

Underwood & Underwood

THE STATE CONSTABULARY IS EXPERIMENTING WITH RADIO

Every evening at about 8.50 *o'clock the Boston police reports are broadcasted from the station at Medford, Mass. This picture shows how these reports are checked at headquarters of Troop A of the Massachusetts State Constabulary forces at Framingham. Experiments are being made there with radio equipment on motorcycles.*

ampere or less (which would have delicate adjustments and light contacts and spring tension), advantage was taken of a vacuum tube to increase the input voltage to the relay circuit, thus making possible the use of a simple ordinary high-resistance telegraph relay. The relay device has therefore been developed to operate from the output circuit of any suitable amplifier in place of the ordinary phones."

The operation of the relay may serve to work a sounder, buzzer, tape register or any mechanism for remote control by radio. By the use of two of these relay recorders connected in series, two messages sent on practically the same wavelength but of different audio-frequencies are caught at the same time and recorded in the operator's absence.

Broadcasting Stations Must Not Interfere With Each Other

"Broadcasting stations should shut off transmitters when they are not in actual operation in order to prevent unnecessary interference from carrier wave," says an official warning from the Bureau of Navigation of the Department of Commerce.

Sending stations are also asked not to interfere with the schedules of other stations; transmitters must be adjusted so as not to produce unnecessary interference. The Bureau has found that some broadcasting stations have interfered over a band from 200 to 500 meters, which hereafter may be reported as a violation of the law, with the subsequent imposition of a penalty.

The Radiophone to Replace Carrier Pigeons

ONE of the impending applications of the radiophone is in the tuna fishing industry, which has been employing carrier pigeons in keeping the boats of the fishing fleet in occasional and uncertain communication with the canneries on the Pacific coast. The fishing vessels set forth on their tuna hunting expeditions early in the season in the waters near Coronado Islands, off San Diego, as the schools of tuna move northward the boats follow. While the fishermen keep more or less in touch with the home ports through the craft which carry back the catches, they have depended largely upon birds, which at best constituted a one-way service. The *Pacific Fisherman* thus points out the possible uses of the radio in developing the tuna fishing industry:

> The radio telegraph now in common use is far too expensive to install and operate for use by small fishing vessels. For this reason, the rapid progress now being made in the manufacture and use of radio telephones is of exceptional interest to the fishing industry. A special investigation shows that this form of communication is now in a state of transition, with improvements developing almost daily, and for various reasons it does not yet seem fully available for general use on fishing boats. In certain cases, however, it might be exceedingly useful, even at the present stage. The transmission of messages is still a complicated matter, requiring the services of an expert; but receiving instruments are available at very reasonable prices, and are easily used, and the broadcasting service is expanding daily. For sending instructions from a central station to cannery tenders and trap watchmen, this equipment might be found of great value; and a few broadcasting stations in Alaska, sending out market quotations on halibut and salmon, in addition to the usual news and entertainment features, should be an exceedingly popular feature with the fishermen.

Is There to Be no Escape from the Collection Plate?

EVEN the passing of the collection plate has become a reality in the church service conducted by radio. So many listeners enjoyed a recent sermon broadcasted from the WJZ station by the Rev. Edgar S. Wiers, pastor of a church in Montclair, N. J., that they sent in by mail their money for the heathen.

International

MUSIC FROM AN OLD CIGAR BOX

Make a wireless set for receiving with only a cigar box, parts of an old typewriter, a piece of an oatmeal box, a few clips off Christmas tree candle holders, and a piece of galena? That is exactly what Herbert Parish, sixteen years old, constructed in less than a half hour, in order to hear the broadcasting of music by radio. The set is said to work satisfactorily over short distances. Any ingenious lad who is handy with tools can do the same.

A Home-Made Radio Set That Received 300 Miles

The remarkable accomplishment of the crystal receiver described in the May issue of this magazine. The ordinary range of such an equipment is only twenty-five miles. The figure below shows the installation.

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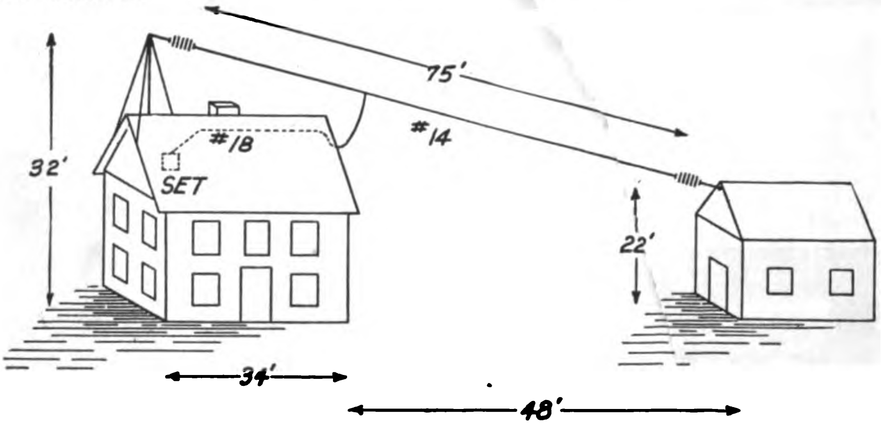

THAT the home-made crystal receiving set as evolved by the Bureau of Standards and described in detail in the May issue of POPULAR RADIO is a thoroughly practical instrument has been demonstrated by the letters which have come to the Editor. Here, for example, is what J. O. Hodge, of Washington, D. C., heard on the small set which he built himself out of material that cost him about $11.00:

Radio concerts in Schenectady, three hundred miles away, have been heard plainly on the crystal receiving set in Washington, D. C., and the Pittsburgh broadcasting program, coming from over the Alleghany Mountains, has been picked up and followed without difficulty. The set was the simple arrangement recently designed and described by the Bureau of Standards. The crystal and head-set, which was the metal diaphram type, were purchased in an ordinary supply store.

Similar results can be attained by anyone under favorable conditions Indeed, this performance should be duplicated wherever there is a good open space for erecting an antenna. In this case the aerial consisted of a single No. 14 wire 75 feet long, 31 feet high at one end and 22 feet high at the other; it was strung between two frame houses in a neighborhood that was free from steel structures and metal framing of any sort, as shown in Figure 1. The set was mounted in a room on the upper floor below the high end of the aerial, but the connection was made by a No. 18 bell wire which ran along the ceiling of the rooms of the upper floor and was connected to the aerial after it had passed over the house about a third of the distance from the high end.

Fading was, of course, noted; that is, the strength of the signals sometimes increased and decreased for periods of 10 or 20 seconds, depending upon atmospheric conditions; this will be the case with any receiving set. Now and then the signal disappeared altogether for a few seconds. However, this was not serious, as whole concert numbers lasting five minutes or so were often received clearly and without interruptions.

C. A. BRIGGS.

An Electron Tube Radio Receiver Without a Storage Battery

A RADIO receiving apparatus that uses ordinary electron tubes for amplification but which does not require a storage battery has been developed by the radio experts of the Bureau of Standards.

The current to light the filaments of the electron tubes is obtained from an ordinary electric lamp socket instead of from the storage battery which the experts characterize as "a drawback to the general use of radio sets and the most expensive portion of the equipment for the person who wishes to make his own set."

How to use the electric light wires themselves as an antenna and thus eliminate entirely the need of erecting an antenna has also been worked out by the government radio engineeers in connection with this new set, although the signals are likely to come in with less

© Ewing Galloway

A SET THAT RECEIVED HALFWAY AROUND THE EARTH

That the radio equipment on the ocean lines "Vauban" is one of the best adjusted on the high seas was recently demonstrated when Chief Wireless Operator F. W. Walsh picked up a message from the Philippines while the vessel was on its way from Buenos Aires to New York—a distance of 11,500 miles.

Kadel & Herbert

WHERE THE RADIO FAN MEETS THE BASEBALL FAN

A New York boy recently entertained the younger element in his neighborhood by bringing his receiving set down on the street below his apartment and posting the scores of the games as they were announced by radio. In between times his audience were entertained by music from the loud speaker.

strength when this is done. The new design of receiving set can be used, however, with any type of antenna.

"The new receiving set consists essentially of an amplifier with minor auxiliary parts," the experts explain. "The amplifier utilizes 60-cycle current supply for both filaments and plates of the electron tubes. This amplifier has three radio-frequency stages and two audio-frequency stages, and uses a crystal detector. The 60-cycle current when used in an ordinary amplifier circuit introduces a strong 60-cycle note which offers serious interference. This has been practically eliminated by balancing resistances, grid condensers and special grid leaks of comparatively low resistance, a telephone transformer in the output circuit, and a crystal detector, instead of electron tube detector. In the final form of the amplifier, there is only a slight residual hum which is not objectionable. The amplification obtained with A. C. supply was as good as that obtained with the same amplifier used with D. C. supply. The complete unit is light, compact and portable. For the reception of damped waves, the amplifier as constructed operated most satisfactorily for wavelengths from 200 to 750 meters; this range was determined by the working range of the radio-frequency transformers used. By using suitable radio-frequency transformers, it is expected that the amplifier will be effective for the reception of damped waves and undamped waves as long as 10,000 meters. For the reception of undamped waves, a separate heterodyne should be employed."

JIMMY—"You take this wireless receiver I just finished makin', and go downstairs in the cellar; hold it close to your ear and listen."

FREDDY—(*After waiting in suspense for several moments in the cellar*), "Aw—it's a fake, I didn't hear a thing."

JIMMY—"Good! That shows it's workin' right. I didn't say anything yet."

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Popular Radio

AUGUST, 1922

Fighting Fire by Radio

How the airplane scouts of the Forest Service
are saving millions of dollars for Uncle Sam

15¢

Vol 1
No 4

Machines Are Controlled by Radio--How to Make a
Condenser--The Law and the Radio Amateur--
Your "Call Letters" Mean--How the Sun Helps Wire-
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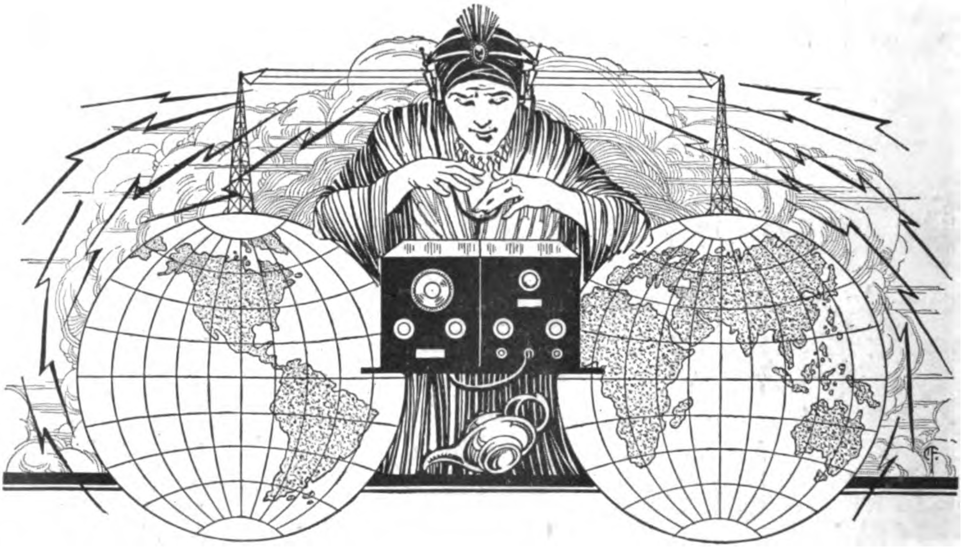

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the Ends of the World

Among the triumphs of inventive genius which have brought the miracles of radio into the lives and homes of millions of people, none so precisely meets the exacting requirements of this new science as the

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As national distributors of the products of leading manufacturers of radio equipment, we are at all times in position to make immediate quantity deliveries on this superior and popular instrument, as well as

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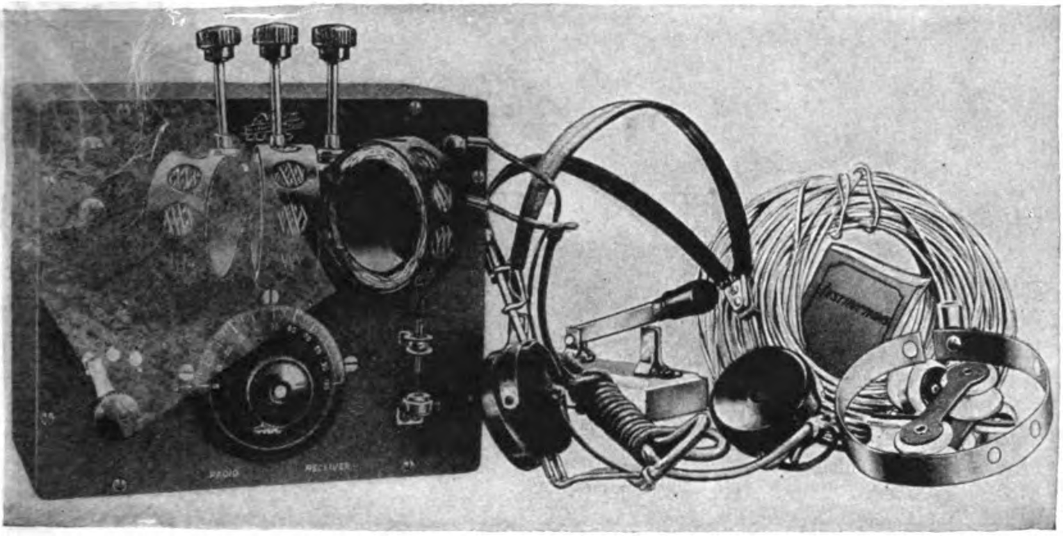

ABC Radio

Crystal Receiving Set No. 5000

$14.75

AS the result of a fortunate *quantity purchase*, we are able to offer this regular $25.00 outfit direct to the consumer at a saving of $10.25.

For a limited time only, we can supply this wonderful ABC Crystal Receiving Set at special introductory price of $14.75.

This beautifully constructed and efficient cabinet receives wireless music, speeches, etc., at a distance of 15 to 25 miles—just right for Tampa residents.

By adding extra units later on, you can possess a fully equipped station second to none.

ABC Radio Crystal Receiving Set No. 5000, with three coils (cabinet as illustrated). Price . . $14.75

ABC Radio Crystal Receiving Set No. 5000 with Completion Package (as illustrated) consisting of aerial wire, insulators, 2000 ohm Murdock head phones with improved Signal Corps type headband, ground clamp and ground switch—a complete receiving station. Price complete, $22.25.

Send Postal Order or certified check today in order to get your set at this special price.

WIRELESS EQUIPMENT CO., Inc.

32 Austin Street
Newark, N. J.

POPULAR RADIO

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(*Cover design by Harry Townsend*)

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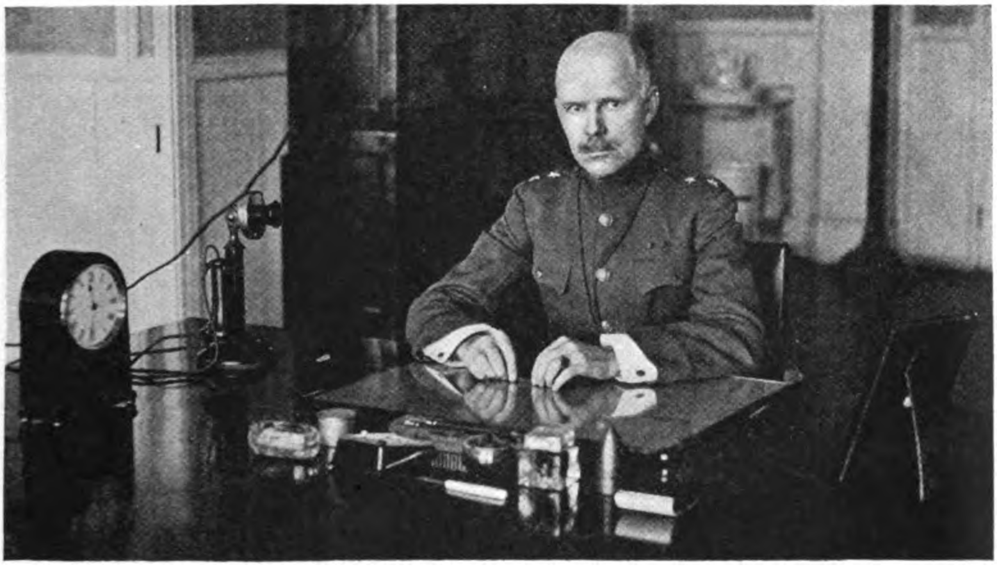


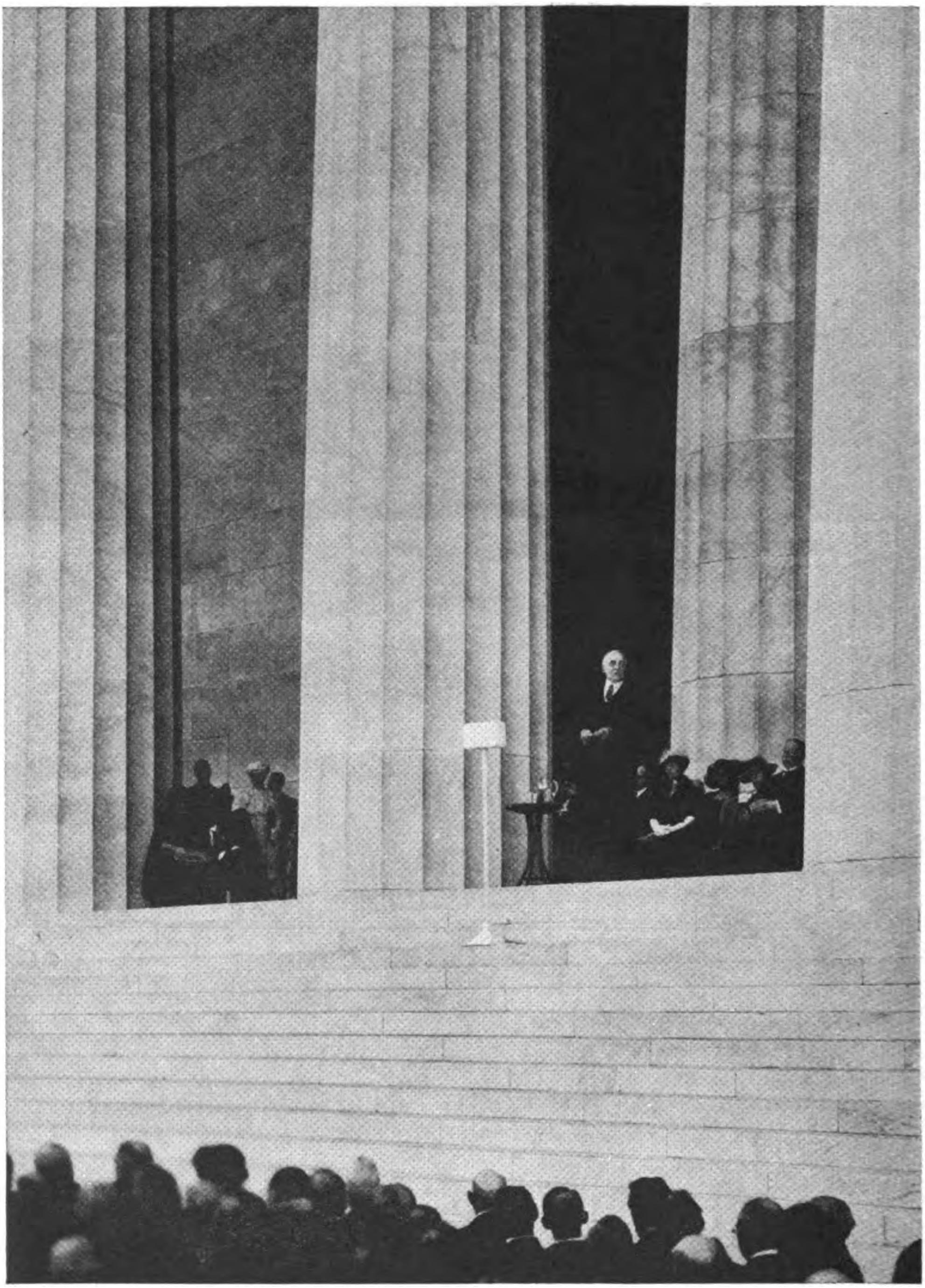
WHAT WILL BE THE FUTURE OF BROADCASTING?

"RADIO broadcasting as now conducted may pass. I think that it will. But it will pass into something bigger and better, into something more useful to men and to society."

Geo O. Squier

MAJOR GENERAL, UNITED STATES ARMY

Speculation concerning the future of radio broadcasting is widespread; opinions vary as to how it may develop. For the next issue of POPULAR RADIO *General Squier, the famous father of "wired wireless", has written a significant and a prophetic article that is of commanding interest to every radio fan in the country.*



Harris & Ewing

THE PRESIDENT SPEAKS TO THE GREATEST RADIO AUDIENCE IN THE WORLD

At the dedication ceremonies of the Lincoln Memorial the President addressed an audience of about 50,000 people. But in front of him was placed a microphone that transmitted his voice to two radio stations—one at Anacostia and one at Arlington—which broadcasted the voice at wavelengths of 412 and at 2,650 meters respectively.

Popular Radio

VOLUME I AUGUST, 1922 NUMBER 4

Fighting Fire *by* Radio

How Modern Science Is Reaching Into the Remote Wilderness to Safeguard Millions of Dollars Worth of Public and Private Property from the Flames

By ARTHUR CHAPMAN

"THE fire has us surrounded. I'm going to dismantle the radio set and take it on a raft, out on the lake, and see if I can't save it."

Such was a vocal message received by a Forest Service radio operator at Lolo Hot Springs, Montana, from the operator at Beaver Ridge, Idaho, across the main range of the Bitter Root Mountains, in August, 1919, at the height of a disastrous season of forest fires.

The stations mentioned were the first ones to be installed by the United States Forest Service to demonstrate the possibilities of permanent radio lookouts in forest fire work. Effective service had been rendered in California, Oregon and Washington by airplanes equipped with radio, communicating with field stations, but these lookout stations in Montana and Idaho were for continuous service. They had been equipped under the greatest difficulties, on account of their location in rough, high ground where ordinary telephone construction was next to impossible. They had been rendering efficient service for more than a month. To have one of the stations wiped out would be regarded as a calamity.

Without a thought of his own danger, the operator at Beaver Ridge, with flames advancing upon his post from every side, dismantled the radio set and carried it down the hill to a small lake, where he built a raft to float it.

Through a combination of lucky circumstances the rangers who were fighting the fire were enabled to keep the radio station from being destroyed. As soon as it was certain that the danger was over, the operator floated his radio set back to shore and had the outfit once more taken back to the lookout station and the outside world was soon being apprised by wireless of conditions in the Beaver Ridge area.

This is only one of many incidents that have enlivened the youngest branch of the Forest Service since radio has been introduced in the work of fire fighting.

In airplane fire patrol work, which has been done extensively and successfully in the Pacific Coast states, radio has improved the one unsatisfactory element—that of reporting fires. Parachutes with messages attached were too uncertain. Carrier pigeons released from the air and reports by telegraph or telephone after landing proved too slow in comparison with the work achieved by systems of lookouts, with specially built lines. In the first official reports to the Forest Service concerning airplane patrol work, the use of wireless was urged as a vital necessity. This need, with others, was so well met that at the conclusion of the last six months of 1919, following a systematic use of airplane patrol with radio, it was reported: "Airplanes are as necessary now to the Forest Service as boats to the Navy."

Six patrol routes covering National Forest areas of high value in California were mapped out and twice each day six Curtiss airplanes covered the greater part of 6,000,000 acres of rough, mountainous, heavily timbered country. The average non-stop run was 160 miles; the average round trip 320 miles. Many fires were discovered, located and reported in advance of the regular Forest Service detection organization, and in addition to performing these duties the regular fire patrol proved of great value in reporting the progress of fires. The patrol observers communicated by radio to the base stations and from there to the ground patrols by telephone. In five months, from June to October, inclusive, 202,009 miles were covered by airplane, and 442 fires discovered, 27 of which were reported in advance of the regular forest patrols and independent of them.

While the development of radio in the aircraft patrol was being carried on, the Forest Service was not overlooking the opportunities of wireless at established points in the National Forest. The Service has created many lookout stations at suitable points in forest areas. These stations are connected by telephone with the offices of the forest supervisor. When an observer at such a station sees a fire, the location is telephoned to headquarters. If the fire appears to be serious, a general alarm is sent to district headquarters and a large force of fire fighters is sent to the scene.

These telephone lines to lookout stations in the National Forests have been constructed at great expense. Most of them have, of necessity, been built through wild and rugged country, sparsely inhabited. Such lines are often threatened with destruction by fire. Sometimes they are destroyed, in spite of all that can be done to save them, and the costly work of installation must be begun over again. Also the stations may be cut off for weeks and new fires may start in other parts of the forest, without being reported. It is like putting out the eyes of the Forest Service when these stations are disabled.

A case in point, which could not have happened had radio been installed, took place last summer in the Clearwater National Forest, where fires were very destructive. More than ninety miles of ordinary telephone line was destroyed, the trees from which the wire was suspended were burned and the wire itself was melted by the heat. Quick communication was at an end and the efficiency of the fire fighting organization was correspondingly diminished. It took more than a week to restore telephone communication with every resource of the Forest Service officials devoted to that end.

Such a halting of communication at the very crisis of a fight against forest fires is in sharp contrast with the incident related at the beginning of this article. With no line of wire communication to worry about, the radio operator at Beaver Ridge who transplanted his outfit to safety on the lake, while the flames went by, was in a distinctly advantageous position.

With no idea of getting the necessary pioneer work accomplished in establishing radio stations, R. B. Adams, Telephone Engineer for Districts No. 1 and No. 4 of the Forest Service, was delegated in the summer of 1919 to study the subject and to ascertain what equipment was best for the purpose. Wireless experts of the War and Navy Departments were consulted and the plants of the leading electric companies were visited in order

From a photograph made for POPULAR RADIO

A RADIO SCOUT OF THE AIR

Few forms of government service offer more adventuresome experiences than the "Forest-Fire Air Patrol" of the Northwest, whose daily flights of several hundred miles over valuable timber tracts not only locate fires before they get far under way but direct the work of the fire fighters below.

to secure the best information possible.

After full consideration, what are designated as SCR-67A wireless telephone sets, used by the U. S. Signal Corps, were decided upon as most promising for the Forest Service in its experimental work in the mountains. Two of those sets were secured and taken to the field for a test of their efficiency. One set was installed at Mud Creek ranger station, near Lolo Hot Springs, Montana. It was determined to erect the other set at Beaver Ridge, which, though only twelve miles by air route from Lolo Hot Springs, is in another state and across a mountain range and is thirty miles distant by trail.

During the preliminary test work, Adams had personal charge of the Mud Creek station and that at Beaver Ridge was handled by his assistant, Everett Cutting. Working in the face of apparently insurmountable obstacles, these men did not quit until they had proved that the radio station had an important place in forest protection work. Theirs was the enthusiasm of an abiding faith, and they demonstrated resourcefulness in overcoming unlooked-for problems which cropped out at every turn.

Transportation presented unusual difficulties at the outset. Carrying delicate instruments by pack train over almost impassable trails for thirty miles is something to tax the patience of the most enthusiastic scientist. One of the worst tasks was to pack the cumbersome storage batteries that had to be used at each station. The two stations had been made ready for business, antennae installed, signals agreed upon, and other details attended to, but no storage batteries had arrived at the Beaver Ridge terminus.

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A RADIO LOOK-OUT ON MT. HOOD

Located 11,250 feet above sea level, this station of the Forest Service receives and transmits reports of forest fires within a radius of many miles.

Word came at last from the packers, indicating to some slight degree the troubles that had been encountered. Three times the Beaver Ridge battery was lost or destroyed in transit. Pack horses had slipped off the trail and packs had become displaced and gone rolling down the mountainside. On the final trip the battery was all but lost, but finally recovered and the pack train struggled on its way and all equipment was delivered.

Antennae hung high on convenient pines, the storage batteries were all in place, and from out of the air the Mud Creek station heard the welcome call, "Hello, Mr. Adams," sent by Operator Cutting from Beaver Ridge—the first telephone call ever transmitted by the Forest Service by radio in the administration of the National Forests. This was on the morning of July 19, 1919. The sets remained in operation and were used for every purpose the telephone would be called for until the last of August, when the temporary removal of the Beaver Ridge set took place as described.

The "hello girls" at modern telephone exchanges, who feel that fireproof buildings equipped with electric lights and fans and steam heating plants and upholstered furniture, to say nothing of restaurants and gymnasiums, probably would be horrified at the primitive surroundings under which these first radio operators in the Forest Service were compelled to work. At both the Mud Creek and Beaver Ridge stations the wireless sets were established in field tents. The flicker of coal oil lanterns afforded the only illumination at night. The operator's seat was a soap box, and the instrument desk was a cracker box. The heat of summer days was sometimes lessened by a wind which menaced the frail canvas "office" of the operator. Under these pioneer conditions Adams and Cutting carried on their work during one of the most disastrous fire seasons on record.

While the sending radius of the sets used was not great, the receiving ability was practically unlimited and wireless messages from many distant points were picked up by the lonely stations astride the Bitter Roots. Perhaps Beaver Ridge was the first place in the inter-mountain region to know that Admiral Rodman's flagship had safely passed through the Panama Canal, for the Forest Service op-

Photo by courtesy of the U. S. Forest Service

A PACK TRAIN OF RADIO EQUIPMENT PENETRATES THE GREAT FORESTS

To pack and transport into the heart of the timber districts of the great Northwest antennae, storage batteries and delicate receiving and transmitting apparatus presents a problem that taxes the patience even of the most enthusiastic scientist.

erator in the mountain wilderness had picked up the naval radio message announcing the fact.

As a result of this first season's work, additional equipment was secured the next year through the Navy Department, in the form of 50-watt telephone transmitting sets. These were used during the summer of 1921 successfully between Buffalo Hump and Warren, Idaho, a distance of from 40 to 45 miles. Prior to the installation of the radio between Buffalo Hump and Warren it required nearly two days to get a message between those two points. With the radio in use, fire calls were handled between those points in about four minutes.

The big problem confronting the Forest Service, according to Mr. Adams, is power. It is necessary to carry everything in the "back country" by pack horse, and, as the weight a horse can carry is limited to 150 pounds, special equipment had to be designed in the form of gasoline charging plants to secure adequate power for charging storage batteries.

Some radio engineers were of the opinion that considerable trouble might result from placing the sets in mineral zones and heavy timber. No such trouble developed, though one set was located in a hole in a heavily mineralized country and the other was in the midst of dense timber and also was close to another mineralized zone.

The power problem at the Forest Service stations was not solved without considerable experimenting. Finally there were used 270 No. 2 Burgess dry batteries, connected in series, to secure the 350-volt plate current required. This did away with the motor generator entirely. However, for the right solution of the power problem, some form of generating equipment similar to the Delco lighting system will have to be used in this mountain wireless work. Gasoline-driven engines, air motors, and different forms of hydroelectric power developed are all possibilities in this connection. Diverse conditions in different localities no doubt will call for the utilization of all these various methods of generating power. The one to be adopted at any particular station must be determined by local conditions.

One valley in the Cleveland National Forest had been a constant source of fires of suspicious origin, until airplane patrol was established. The knowledge that an airplane operator in forest patrol work has a powerful telescope and radio at his command cannot fail to have a beneficial effect on that type of incendiary whose specialty is starting forest fires in order to be put on the government's payroll to fight the very flames for which he is responsible.

The airplane patrol work in the National Forests was undertaken by the Air Service Branch of the War Department, with Air Service personnel and equipment and at Air Service expense, at the request of the Forest Service and with the cooperation of that department and the Signal Corps. Radio on the airplanes themselves and at the bases is handled exclusively by the Air Service; all other radio is handled by the Signal Corps. An officer of the Forest Service acts as liaison officer at each base and receives all reports by radio or by pilots landing, which

Photo by courtesy of the U. S. Forest Service

THE FIRST MAN TO USE RADIO IN FIGHTING FOREST FIRES

Facing what at first appeared to be unsurmountable obstacles, R. B. Adams, engineer for Districts No. 1 and No. 4 of the Forest Service, undertook to establish radio service in the wilderness of Montana early in 1919. This picture shows the original set on which was received the first radio message ever transmitted in the administration of the Forest Service.

reports he in turn transmits to the forest supervisors.

The value of radio has been proved not alone in reporting fires but in directing the operations of fire fighters. The best example of this use of radio occurred at the Mill Creek fire, covering some 12,000 acres in the Lassen National Forest. A portable radio receiving set was taken to the fire line by truck and by pack horses. A special airplane was detailed to the fire, to perform two duties, the first being to circle the entire fire, report conditions and direct the fight so far as possible, the second duty being to patrol the fire line.

With the receiving set directly on the fire line, and with the use of the liaison officer for a part of the time, and the most experienced observer during the remainder of the duration of the fire, it was found possible to get practical directions from the plane regarding the best disposal of the fire-fighting crews.

The airplane patrol of the fire line was determined upon as the best means of conserving the available force of fire fighters. During the progress of the fire there was from ten to fourteen miles of fire line to watch. Men were scarce and the fire was uncontrolled on the other side. It was determined to take every available man from the fire line and concentrate the entire force on the other side of the fire. The ship came down to an altitude just above the tree-tops and made a detailed patrol of these fourteen miles of fire line. The radio reports of the operator were relied upon absolutely. If he reported the fire line as clear, the men were all kept at the big task of fighting the fire on the other side. But if a radio report came back to the effect that the fire had broken over, or was about to do so, men were sent to the threatened point on the fire line and the danger was averted. This is the first time, as far as Forestry officials know, that a successful patrol of a fire line has been made—and this would not have been possible had it not been for radio.

The advantages of radio for quick reports were demonstrated following unusually severe lightning storms on the Lassen forest. Thirty-two fires were started by lightning in one district within two days. Similar airplane reconnoissances were made on the Klamath and the Plumas forests after severe lightning storms, with excellent results from the wireless reports.

Locating a forest fire "accurately" in Forest Service parlance means within a quarter of a mile of the actual scene of the fire. This is not as easy as it sounds, even when the locating is done from an observation station where the operator has powerful glasses and scientific instruments to aid him in his work. District Forester Paul G. Redington reports that 33 percent of the fires discovered by the airmen operating out of Mather Field in California, and reported by radio, were located "accurately." An additional 19 percent of the fires reported were within a half mile of their actual locations. Ten percent were located by the Air Patrol before the forest rangers knew of their existence, and eighty-three fires, or 42 percent of the total, were reported by radio while the airplanes were in flight. Fifty-eight percent, therefore, were reported after the airplanes had landed.

In Oregon seven airplanes were assigned to the Eugene base and four to the Medford base—all equipped with radio sets. The first sets furnished by the Signal Corps were found to be of too low receiving power to be as effective as was desired. New sets were furnished and the patrols kept in constant touch with each other. During the first season of operations in Oregon, local amateur wireless operators caused considerable annoyance by sending messages while the machines were in flight, but as soon as their attention was called to the trouble in receiving fire reports most of them refrained from using their instruments during patrol periods.

A radio-telegraph transmitting outfit designed by the Signal Corps of the United States Army, labelled as type

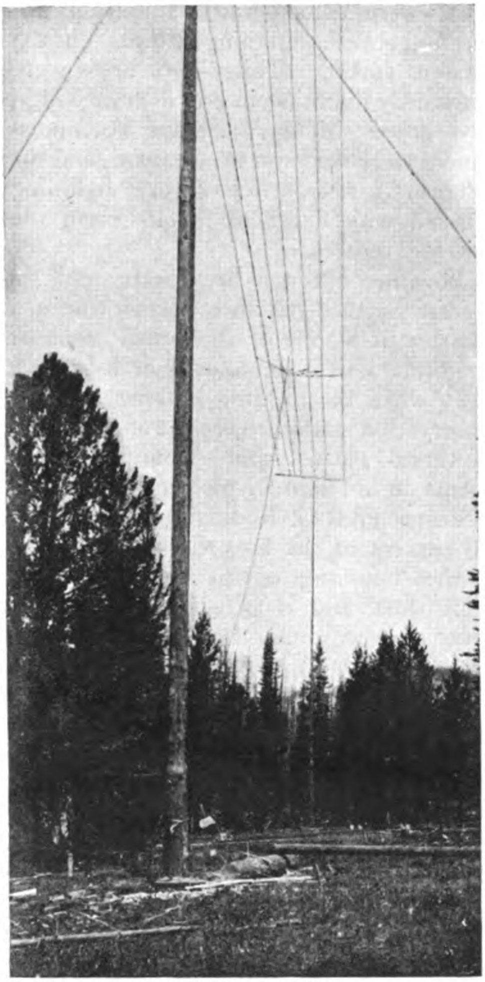


Photo by courtesy of the U. S. Forest Service

AN ANTENNA IN A REAL WILDERNESS

Erected in the Nez Perce forest. The poles are 98 feet high with a 210-foot span; the seven antenna wires are spaced 2 feet 10 inches apart.

SCR-73, is employed on fire-detection aircraft. The equipment is of a damped-wave design, obtaining its power from a self-excited inductor type alternator. The latter is propelled by a constant speed air-fan or possibly a fixed wooden-blade air-fan designed for training purposes. The alternator, rotary spark gap, potential transformer, condenser and oscillation transformer are self contained in the stream-line casing of the alternator. The latter is customarily mounted on the underside of the fuselage where the propeller spends its force in the form of an air stream. The only units included inside the fuselage are the telegraph sending-keys, field and battery switch, dry battery in its holder, variometer, and antenna reel.

This type of transmitter conforms to the description of being a simple rotary gap, indirectly excited spark, provided with nine taps on the inductance coil of the closed oscillating circuit. Nine different wavelengths are possible, and five varying toothed discs for the rotary spark gap yield five different signal tones. These two variations afford forty-five different combinations of wavelengths and tones. Thus, it is feasible to press into service a series of airplanes for detecting forest fires in a restricted area without interference putting in its discordant work.

The wavelengths and tones of this transmitting set are brought into harmonious operation when the airplane is on the ground. Once the machine leaves the earth, this apparatus is not available to either the pilot or observer. The only adjustment effected in the air is that accomplished by a variometer mounted in the fuselage which brings the open oscillating circuit into harmony with the closed circuit as indicated by the maximum current reading on a hot wire ammeter in the variometer box. There is no battery to go "dead" or other auxiliary units to fail. The hot wire ammeter tells whether or not signals are being radiated.

A two-way radio-telephone set is employed on an airplane at each sub-base for directing the fire-fighting crew at big conflagrations. A Signal Corps design, bearing the number 68-A, is used for this purpose, the outfit having a wavelength range from 215 to 450 meters. A special constant voltage generator supplies the power for transmitting and for heating the essential vacuum tube filaments. Other accessory units of this radio-telephone outfit are: a filter box, a radio set box, an interphone set box for affording communication between the pilot and observer, two head sets and telephone transmitters, with the necessary connecting cords.

A damped wave airplane receiving set, known as Signal Corps design No. 54, was installed on the ground at the forest supervisor's headquarters in each National Forest. Here reports of detection of fires were received from airplanes making semi-daily patrols. This receiving outfit involves the use of both primary antenna and secondary circuits. These may be tuned by means of the variable capacitance and variable inductance found in both circuits. Across the secondary condenser is connected the detector and telephone circuit. A separate buzzer circuit is installed in the cover of the box to excite the set when adjusting the crystal detector.

An airplane assigned as a forest-fire patrol submits its radio equipment for thorough inspection before leaving the ground. In advance of its departure from the vicinity of the airdrome, the patrolling airplane is required to call the radio station and obtain its "O. K.," which signifies that both the radio installation on the flying mechanism and ground wireless apparatus are functioning satisfactorily. The machine then soars along its well-defined route, sending back by wireless its observations according to pre-arranged time schedules.

This knowledge from out of the sky by the medium of ether is received both at the base of the Air Service and at the receiving headquarters of the Forest Service over which the plane chances to be flying at that particular time.

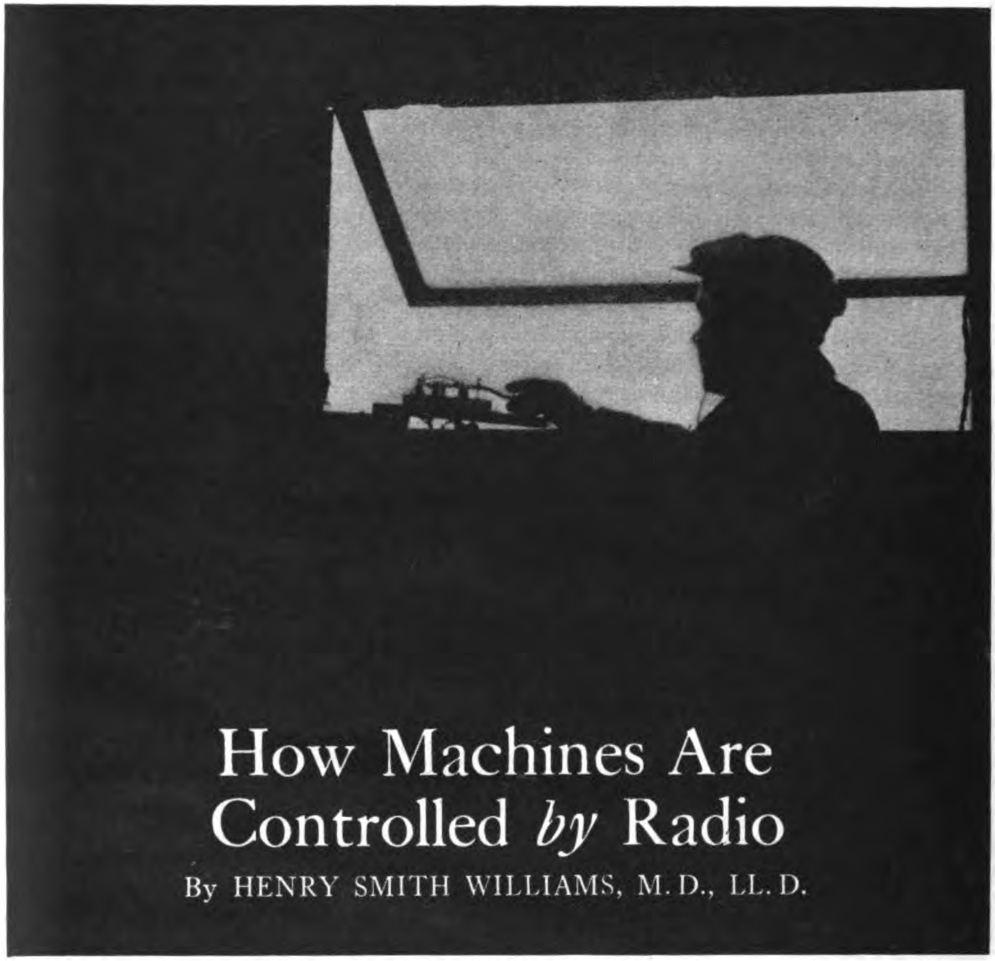
With the arrival of the machine at another base, ordinarily for the purpose of the pilot and observer eating dinner, the list of observations is forthwith deposited with the wireless operator who transmits the reports by wireless to the main headquarters. This act serves as a verification of the report previously dispatched by radio from the machine while on its observation tour.

The main question concerning the development of radio as an aid in the administration of forests is: What is the Forest Service going to do, exclusive of any aid from other departments? In airplane patrol, dependence must naturally be placed upon other branches of government service. This support may be withdrawn, through necessity, at a most inopportune time. Consequently it is felt by Forest Service officials that the substantial development of radio must come from within the Service itself. They are planning for and looking forward to the addition of equipment of their own.

Adams' work in Montana and Idaho, under District Forester Fred Morrell, seems to afford a foundation for substantial development. He has demonstrated that it is possible to equip radio stations successfully in the most isolated regions. Wherever any sort of a trail can be built, the rest can be left to that gifted and patient individual, the master of the pack train, who has not yet disappeared from the West.

The losses that can be prevented by radio communication, either from lookouts or aircraft, will soon pay many times over for any cost of installation and maintenance. The value of only three of the great National Forests is estimated at nearly $63,000,000. From 1910 to 1917 inclusive there were 5,313 fires in all the National Forests, burning 1,163,756 acres of timber annually valued at $3,758,356. On state and private lands, from 1915 to 1917, 2,873 fires occurred, burning 8,052,945 acres of timber, a loss of $9,875,000, not including the losses suffered in the great Minnesota fire.

Radio seems to mark the next great step to be taken in forest conservation in this country. With radio reports being sent from permanent lookout stations and from airplane patrols, giving the exact locations of fires in their incipiency, and with radio operators in airplanes hovering above forest conflagrations and directing the work of the fire fighters below, it seems that science has spoken its final word in forest preservation—and has spoken in actual voices from the clouds.



How Machines Are Controlled *by* Radio

By HENRY SMITH WILLIAMS, M.D., LL.D.

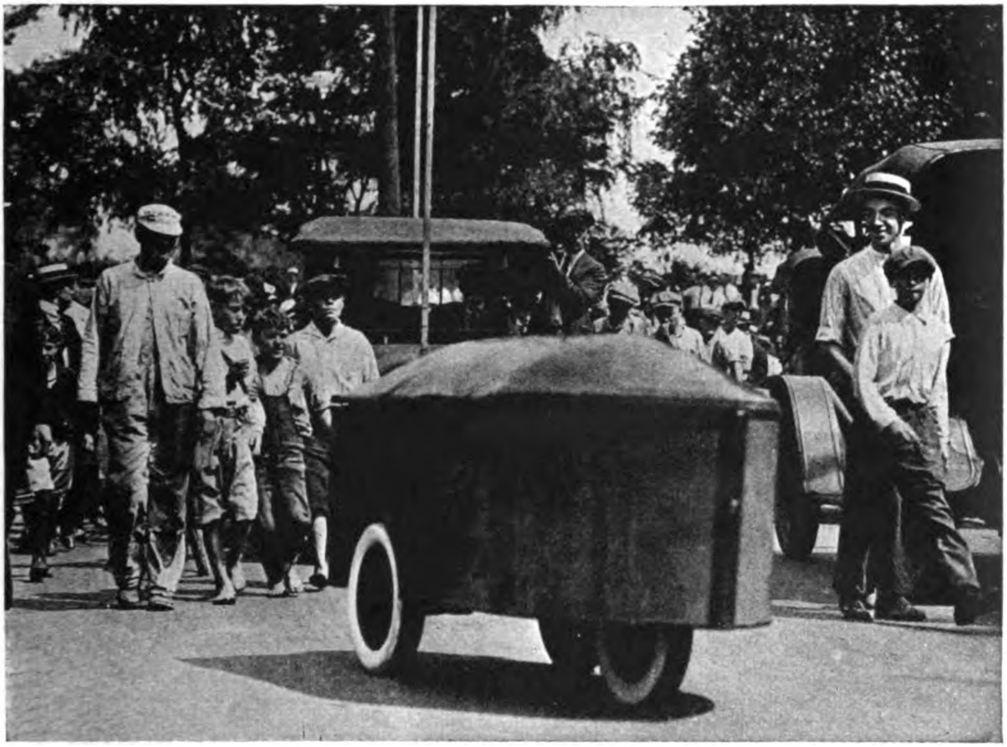
International

For Over a Quarter of a Century Boats, Motor Cars, Torpedoes and Airplanes Have Been Directed by Wireless Impulses—This Article Describes the Mechanism of One of the Latest of These Devices

NO radio apparatus exhibited in New York has attracted anything like the popular attention bestowed on Mr. E. P. Glavin's mystifying little automobile that is controlled by wireless.

I use the word "mystifying" advisedly, even though there is no secret as to the way in which Mr. Glavin accomplishes the wonder. A wonder it remains, however, even after the fullest explanation. The greater your knowledge of radio, in fact, the more fully you will agree to that.

You see Mr. Glavin standing at the side of the room, a solid-figured man with gray hair and strong, thoughtful face; you are at once struck with his resemblance to that other wizard in the field of electricity, Thomas A. Edison. The little automobile, somewhat boat-like in shape and with a mast that heightens the resemblance, stands in the middle of the floor. It is indeed a prosaic looking vehicle; its metal covering might give the impression that it is a model of some new type of armored "tank." At a distance, your only clue to its real character, is supplied by the coil of wire that ascends as a spiral about five or six inches in diameter that winds about the mast from bottom to top, where there is a little electric signal light. On closer inspection you might see within the open body of the vehicle a series of electric batteries and sundry mechanical devices, but even that glimpse would probably make you not much the wiser, even if you are a skilfull mechanician. About the only obvious feature is a central wheel, the rim of which projects into the body of the little car, to which the propelling mechanism is attached. The single front wheel, it may also be noted, serves to guide the vehicle to left or right, just as a bicycle is guided. But there is no bicycle



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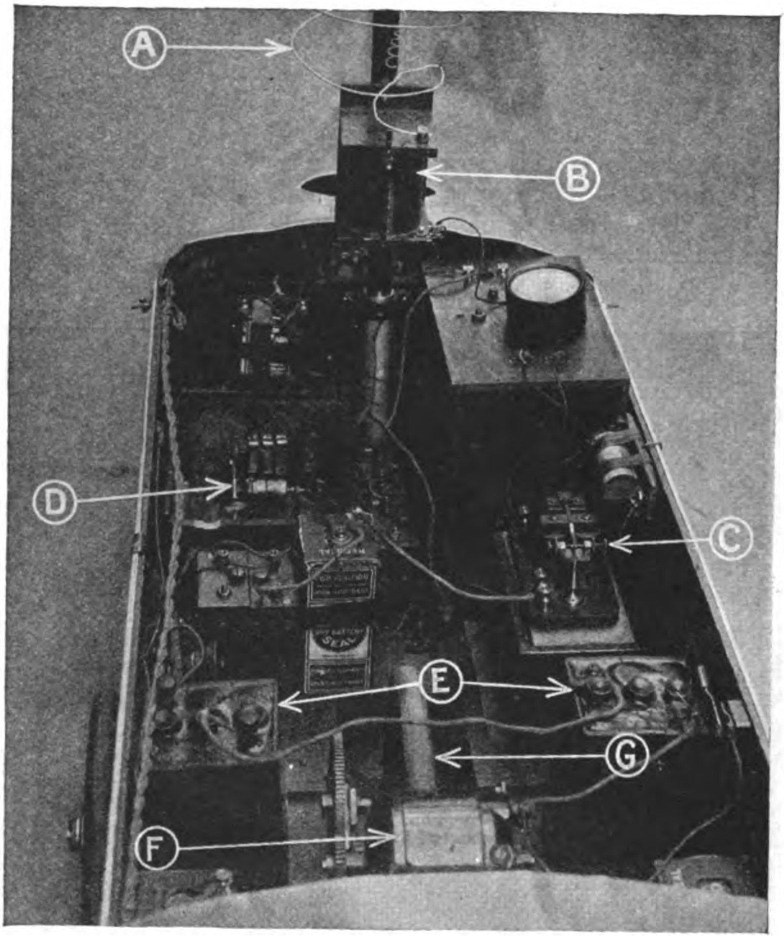
A SMALL "TANK" WINDING ITS WAY THROUGH CROWDED TRAFFIC

A spectacular demonstration of a radio-controlled automobile—the fore-runner of a radio-controlled tank—was given in the streets of Dayton, Ohio, on August 5, 1921, at an hour when the traffic was heaviest. This car was developed by Captain Raymond E. Vaughan, Chief of the Radio Branch of the Engineering Division of the Air Service, U. S. A. at McCook Field. The car was eight feet long, three feet high and two and a half feet wide. It was propelled by motor and storage batteries at a speed ranging from four to ten miles an hour, and was controlled entirely by wireless signals transmitted from an automobile that followed in its rear; Captain Vaughan states "the controls would be effective at a distance of 50 miles and could be operated from an aeroplane as well as from the ground." It was stopped, started, reversed, steered; made to blow a horn, ring a bell and fire a pistol by the pressure of buttons on an automatic transmitter that sent out various combinations of dots and dashes that caused certain controls in the car to function. The "brains" of Captain Vaughan's car is the selector—an apparatus about as large as a saucer which decodes the combinations of dots and dashes and puts the desired controls in operation within a quarter of a second. Any one of the twelve controls can be made operative in less than one second. The possibilities for operating war-machines on the same principle give these demonstrations a prophetic significance.



From a photograph made for POPULAR RADIO

INSIDE INFORMATION ON THE CONTROLS OF THE RADIO CAR

The essential working parts, by means of which the vehicle is controlled, are as follows: A is the spiral antenna; B is the tuning coil; C is the sensitive relay operated by the feeble radio currents; D is the control switch which is set into action by the closing of the contacts of the relay; E are the storage batteries which furnish the electrical power to the motor F, and G is the propelling wheel.

handle or other mechanism in sight by which the wheel might be turned.

Mr. Glavin, standing perhaps twenty feet away from the car, raises his hand. You note that the signal light at the tip of the mast flashes, but nothing more tangible happens. Another slight motion of Mr. Glavin's hand. Now the car starts forward and begins its strange journey. It glides along at a moderate pace, like a tank leisurely charging the mass of spectators, but before it reaches them it circles to the left, and moves back toward the point from which it started.

Mr. Glavin's face is impassive, but from time to time he lifts his hand with a little movement as of salutation; each time he does so you note that the car changes its course. It circles to right as well as left; it cuts a big figure eight; with seeming intelligence it turns its prow just in time to avoid collision with the spectators.

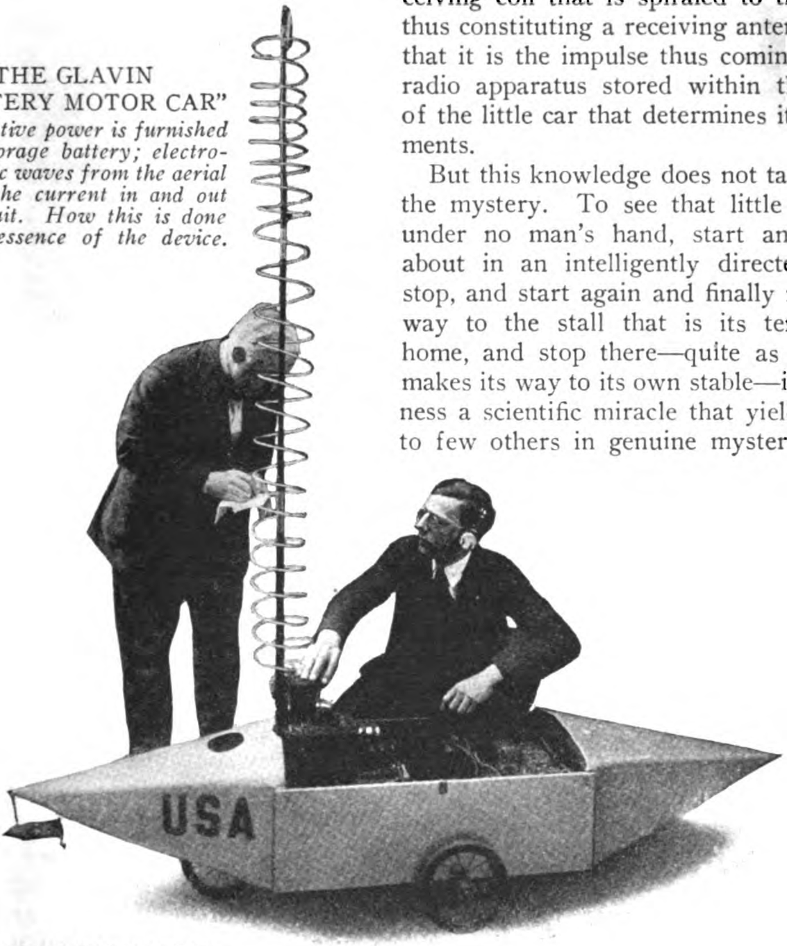
I chanced to be standing beside Mr. Glavin on one of the occasions when the car was making such a journey.

"Now I will have it come around and stop right in front of us," he remarked quietly. A wave or two of the hand and the thing was done! It was hard to avoid the feeling that this weirdly responsive little vehicle, as it circled about and came toward us and stopped respectfully four or five feet away, was manifesting actual intelligence and consciously responding to the mandate of its master.

There was a time when an exhibition like that would have been labeled "wizardry," and an interpretation would have been put upon the word that would have boded ill for the exhibitor. The word "wizardry" still applies, but it now has scientific instead of superstitious implications. The medieval interpretation would have condemned the inventor for consorting with evil spirits, the modern interpretation explains that he is juggling with electromagnetic waves in the ether.

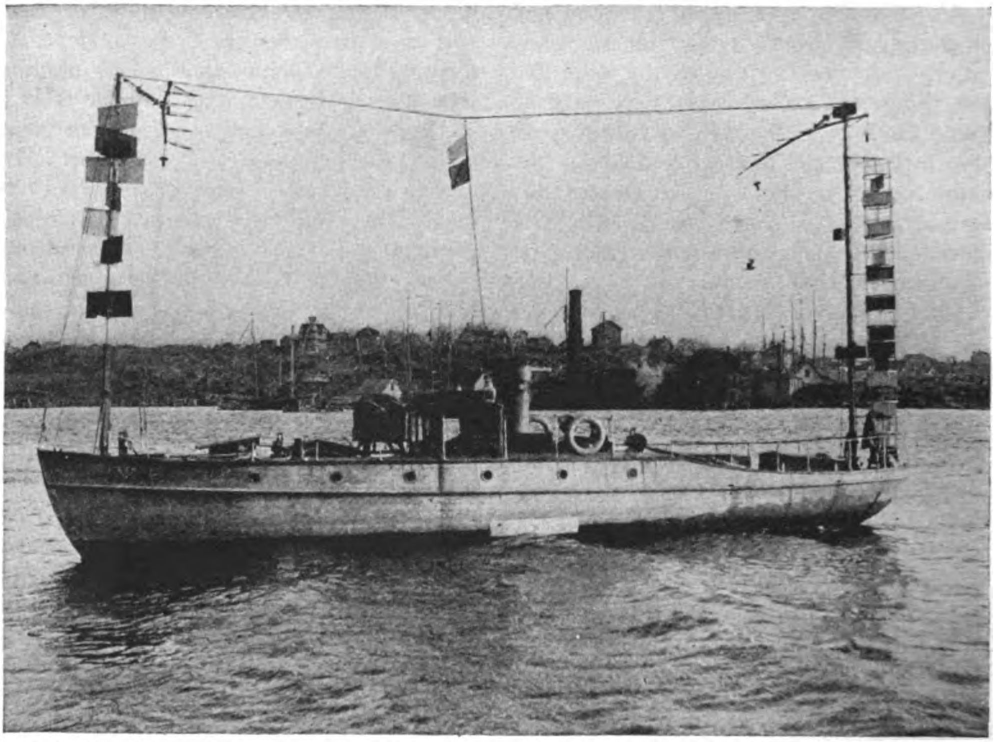
There is, as I have said, no mystery about the method of operating Mr. Glavin's device. Every observer is aware that the little car makes its pilgrimage under radio control. Everyone knows that when the director lifts his hand he is merely signalling to the radio operator a short distance away. The operator touches a telegraph key connected with an ordinary transmitting apparatus that operates in connection with a short two-wire aerial. Everyone knows that the electromagnetic waves sent out from the aerial are caught up by the receiving coil that is spiraled to the mast, thus constituting a receiving antenna, and that it is the impulse thus coming to the radio apparatus stored within the body of the little car that determines its movements.

But this knowledge does not take away the mystery. To see that little vehicle, under no man's hand, start and move about in an intelligently directed path, stop, and start again and finally make its way to the stall that is its temporary home, and stop there—quite as a horse makes its way to its own stable—is to witness a scientific miracle that yields place to few others in genuine mystery. The



THE GLAVIN
"MYSTERY MOTOR CAR"
The motive power is furnished by a storage battery; electromagnetic waves from the aerial throw the current in and out of circuit. How this is done is the essence of the device.

From a photograph made for POPULAR RADIO



International

A FORE-RUNNER OF A RADIO-CONTROLLED NAVY

Several years ago the youthful "wizard" of Gloucester, Mass., John Hays Hammond, Jr. attracted world-wide attention by demonstrating how a yacht could be directed by radio impulses sent over a distance of several miles. These experiments were followed by the development of radio-controlled torpedoes.

builder of radio apparatus can tell how the thing is done in mechanical terms. The mathematician can calculate the energy involved. But no man can give what could properly be called a full explanation of the mystery.

It is possible, of course, to go a little more into detail as to the precise steps of the series of processes by which a wave of the hand appears to be translated into the propulsion of a vehicle—not only appears to be, but really is so transplanted, if we accept words in their proper meaning.

But what takes place within the mechanism of the vehicle when the wireless impulse is received from the transmitting aerial?

At the outset it must be understood that the radio waves which determine the activities of the little car do not supply the energy of propulsion. By no possibility could they do that. The electromagnetic waves that come from the aerial could no more turn the driving wheel and propel the vehicle than could the same feat be accomplished by those other electromagnetic waves termed rays of light which pass from Mr. Glavin's hand to the eye of the operator of the radio-telegraphic key. The radio waves convey more energy than the light waves, to be sure; but in no conceivable way could they convey enough energy to propel a vehicle weighing eight pounds, let alone eight hundred.

Most of the observers are well aware of that. They understand that the actual propulsion of the wireless car is effected by a storage battery which is a part of the internal mechanism of the car itself. A little dynamo that differs in no essential from the dynamos that propel other electrically-driven vehicles—from automobiles to trolley cars—metamorphoses the energy of the storage battery to energy of molar motion—and turns the wheel. The electromagnetic waves from the aerial serve only the function of the motorman on the trolley car, they throw the electric current in or out of circuit.

It is the way in which this is accomplished, however, that constitutes the essence of Mr. Glavin's invention.

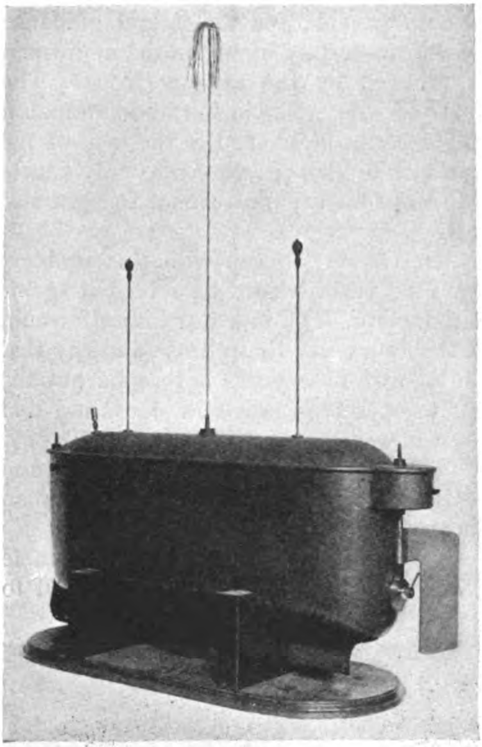
This statement does not do full justice to the problem. It is necessary not merely to throw on and shut off current, enabling the car to start and stop (which is all that the motorman on the trolley is called upon to do), but it is necessary also to provide for the lateral guidance of the car, a duty of which the motorman is relieved by the railway irons. The feat of Mr. Glavin's radio-automaton might better be likened to the task of the automobile driver who not only starts and stops his car but turns it to right and left.

Mr. Glavin labored with this problem for nine years before he solved it to his satisfaction. The inventor himself would probably qualify that phrase and say that he labored nine years before he got the car to operating as it now does, and that even now he feels that he has made only a tentative solution of the problem and is by no means satisfied with it as an ultimate achievement.

But the present achievement is notable enough to satisfy most inventors and to

HE LABORED NINE YEARS TO MAKE HIS RADIO CAR WORK

Not so many generations ago this inventor, E. P. Glavin, would have been condemned for consorting with the evil spirits that propelled and guided his miniature motor car. Modern science, however, knows that he is merely juggling with electromagnetic waves in the ether—until ultra-modern science disproves the existence of ether and proclaims another explanation of the phenomena of radio.



TESLA'S FAMOUS "TELAUMATON"

As far back as 1895 Nikola Tesla gave demonstrations in New York of this radio-controlled boat. It was eight feet long, and was operated in a large tank. The inventor made the boat go through many evolutions, turn lights on and off and fire miniature guns—to the consternation of the public to which radio was practically unknown.

excite the wonderment of all beholders. The mechanism involved, so Mr. Glavin assures us, is relatively simple; important mechanical devices almost always are simple when perfected. In this case, the mechanism that shunts the current from one circuit to another consists of a small drum actuated by an electromagnetic dog-and-rachet arrangement. Released by one signal, the drum rotates enough to bring a brass collar in contact with poles of the battery, thus establishing a circuit that lights the electric lamp at the top of the mast head. A second signal releases the drum and permits it to turn into the next position, where another brass collar establishes the circuit that enables the dynamo to actuate the propelling wheel. The motorman has turned his lever and established the circuit, and the car is in motion.

Now comes the third signal, and this (while leaving the propulsive current in circuit) permits another shift of the drum, bringing into action an electrically-driven power that turns the guiding wheel to the left. The car now circles to the left until the next signal brings the wheel back again; then it will go straight ahead again until the sequential signal turns it to the right.

There are twelve signals in the entire series, and the successive shifts of the drum necessarily take place in an unvarying sequence. Straight ahead—turn to the left—straight ahead on a new tangent—turn to the right—straignt ahead on a new tangent—turn to the left—and so on. There is no way of changing the succession of the signals.

Nevertheless, the car can be made to take any desired course—as can the man-driven automobile. If Mr. Glavin wishes the car to make its first turn to the right instead of to the left, he merely gives three signals in rapid succession after the vehicle is under way. The three signals can be given in less than a second's time with the result that the drum will shift so rapidly, that the left-turn circuit and the back-to-center circuit are passed before the wheel has fairly begun to respond and the turn-to-right circuit appears to have been directly established. In other words. the undesirable signals were "jammed" and rendered inoperative.

Such, then, are the essentials of Mr. Glavin's invention. In a sense it is simple, yet of all radio marvels, few are more thought-provocative than this.

¶ *The next article by Dr. Williams will describe the latest experiments in the transmission of radio impulses over wires and the amazing applications and possible developments of this phenomenon in our every-day life—including the use of telephones on moving trains.*

Why the Sun Makes Possible Long-Distance Wireless

As every radio operator knows, sunlight appears to have a blanketing effect upon radio communications. But the energy exerted by the sun's light also drives into the earth's atmosphere the solar dust which creates the "Heaveside layer" or "wireless screen," which is a tremendous advantage. This article tells how and why.

By E. E. FREE, Ph.D.

LONG distance wireless is one of those impossible things which has been done.

In the early days of radio-telegraphy the experts wrote convincing papers to prove that the transmission of wireless signals across the ocean was impossible, that it would require an impossibly large power. That it couldn't be done.

And then Marconi did it. Accomplished the impossible. Sent signals across the Atlantic with a small fraction of the sending power that the experts said would be necessary.

Transoceanic wireless became an everyday matter. Presently the signals from European stations were detected in Australia—clear on the other side of the earth. These were actual accomplishments. Yet they were "impossible," and contrary to all theory. Obviously it was time to revise the theory.

This is the story of how a new theory has been formulated and tested, how wireless experts came to believe that the whole matter is explained by an action of the sun, by solar dust shot out from the sun's surface and caught in the upper levels of the earth's atmosphere. Were it not for this dust, this beneficent solar bombardment of our atmosphere, the most powerful known wireless station would reach only a few hundred miles instead of the 12,500 miles which it does reach, a distance half way around the earth.

From a photograph made for POPULAR RADIO

HE MAKES COMET TAILS IN HIS LABORATORY

In order to demonstrate that light exerts pressure, Prof. Gordon Ferrie Hull of Dartmouth College, in collaboration with Dr. Ernest Fox Nichols, devised the "comet tube" shown in this picture. This tube demonstrates how fine dust is driven sideways by light, as in the cases of comet tails. This action of light pressure drives dust from the sun into the earth's atmosphere, thus making long-distance radio communication possible.

First we must see why the ordinary theory of wireless waves made long distance transmission seem impossible.

The ether waves which carry wireless messages are supposed to go outward from the sending station in every direction through space, to spread in an ever-growing sphere, just as the water-wave on a pond spreads in an ever-widening circle. The farther the wave has to go the weaker it becomes. Most of the energy supplied to it by the sending station, is lost in space. Only the tiniest fraction of this energy reaches the receiving station and is picked up. For practical wireless communication to be possible the original wave has to be strong enough so that this final tiny fraction of the wave picked up by the receiving station retains enough energy for perception.

Now the actual energy of this fraction in any given case can be calculated theoretically from the intensity of the wave at the sending station, the distance, the size of the receiving antennae, and from other details. For an actual instance of transmission between the great sending station at Nauen, near Berlin and the Panama Canal, the received current was theoretically calculated by Dr. L. W. Austin as about six ten-millionths of one microampere.

Was this the actual current received? Far from it. The actual current was 1.3. microamperes, over two million times stronger than it should have been theoretically.

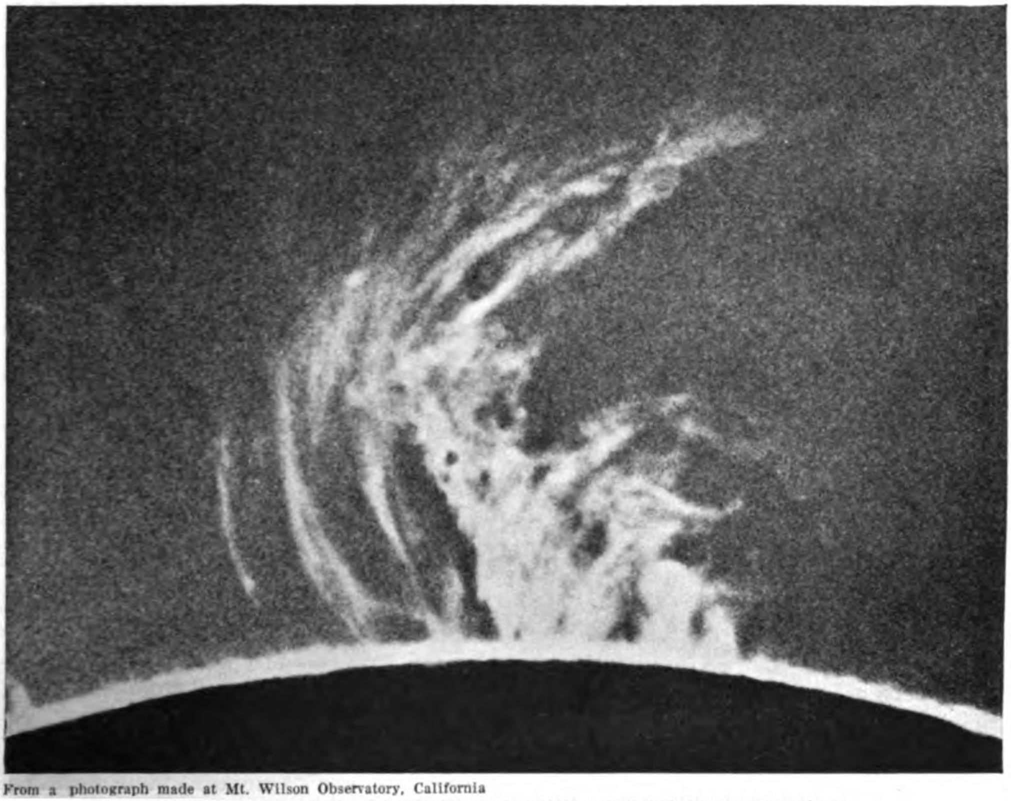
This was a help for the practical wireless men. Something in the ether was helping them out. It was not so simple for the theorists. They had the job of finding out what this helpful something was.

Obviously it was something which de-

From a photograph made at Lick Observatory, California

THE LIGHT OF THE SUN MOVES THE COMET'S TAIL

The minute dust-particles of which a comet's tail is composed are driven backward by the pressure of sunlight. To this phenomenon of light much of the radio communication on the earth is made possible.



From a photograph made at Mt. Wilson Observatory, California

THE ORIGINAL SOURCE OF THE "WIRELESS SCREEN" AROUND THE EARTH

This is a photograph of a "solar prominence," or in other words, a storm of fire on the sun. This particular storm is driving the white-hot flames 100,000 miles high; sometimes these prominences are 300,000 miles high. It is the dust driven outward by such disturbances that reaches the earth and forms what Dr. Fleming calls a "wireless screen."

creased the loss of wireless energy out into space. The waves were held close, somehow, to the earth's surface. In the words of Dr. J. A. Fleming, speaking last Winter before the Royal Society of Arts:

"The upshot of the whole matter then is this: Long-distance radio-telegraphy, say, round one-quarter of the circumference of the earth, would certainly be quite impossible but for some force operating to compel the waves to follow round the earth's curvature and not glide quickly off it."

This conclusion, the conclusion that ether waves are tied somehow to the curvature of the earth, that they bend with it and follow it instead of being deported into space, has just received strong confirmation from the experiments of Lieut. Guierre of the French Navy. Lieut. Guierre has been cruising about in the ocean near Australia and has been observing the clearness with which he could pick up the signals from the great French stations at Lyons (14,000 meters) and at Nantes (9,000 meters) located approximately on the other side of the earth.

He finds that the signals from Lyons are much stronger when his receiver is exactly opposite Lyons, exactly through the earth from Lyons. That is, when the receiving station (Lieut. Guierre's ship) is exactly at the antipode of Lyons. The same is true of the signals from Nantes. They are stronger at the exact antipode of Nantes, at the other end of the earth.

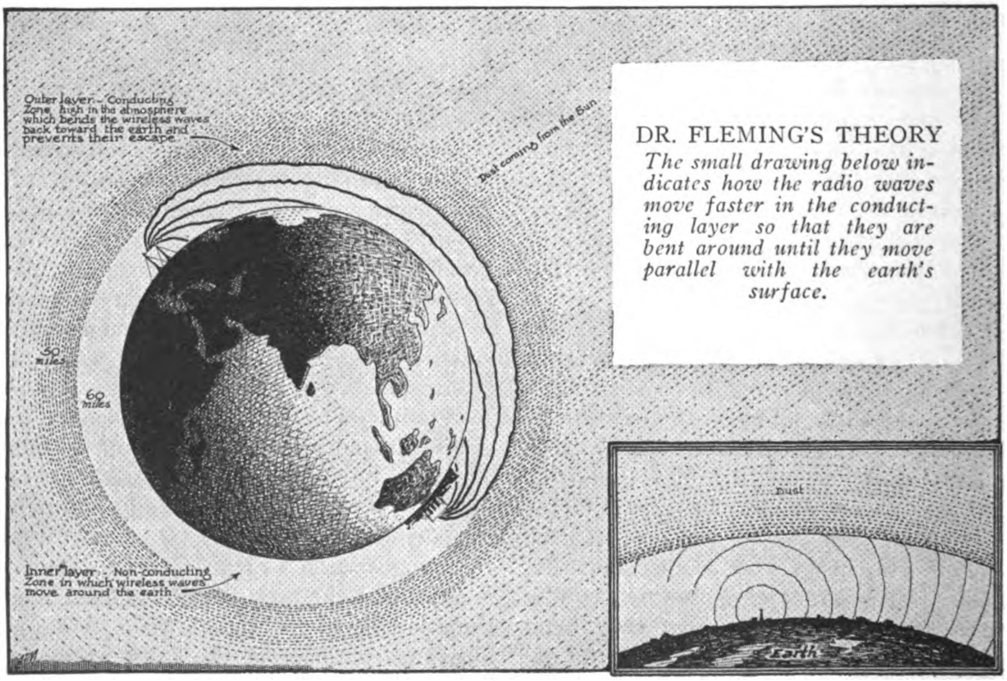
It is evident that the ether waves from Lyons or from Nantes bend around the earth in all directions, and curve inward finally toward a point exactly opposite the sending station. At this point, this antipode, they reinforce each other. The waves which came around one way, over America, reinforce those which came the other way, over Europe and the Indian Ocean. Hence the signals are strongest exactly where the waves meet, exactly at the antipode.

No one doubts nowadays that the ether waves do bend this way around the earth, that wireless follows the earth's surface as flies crawl about an orange. The question is *why?*

The latest answer is found in the solar theory of the possibility of long distance wireless, thanks to Dr. J. A. Fleming, whom I quoted. He suggests that the solar dust creates far up in the earth's atmosphere a layer which conducts electricity, a layer which imprisons the wireless waves and makes them follow about the earth. Terrestrial wireless, says Dr. Fleming, is transmitted almost entirely in the non-conducting skin or shell which lies between this conducting layer of the upper atmosphere and the surface of the earth.

The idea that particles of dust are shot out by the sun and reach the earth is not new. Many physicists have worked out this idea, notably Dr. Svante Arrhenius of Sweden. The cause is the intense disturbance on the sun's surface in addition to what is called the "pressure of light." In an earlier article in this magazine* I discussed the matter of solar disturbance and explained how the tremendous and continual storms on the incandescent surface of the sun force up great columns of glowing gas, of iron and carbon and other elements that are all so hot that they are gases and not solids, as they are on earth.

These glowing gas clouds cool off a little when they get far enough up from the sun's surface. The iron vapor condenses to tiny droplets of molten iron and then cools to tiny particles of solid iron. Other elements do the same. Far above the sun's surface, thousands or


Outer layer - Conducting Zone high in the atmosphere which bends the wireless waves back toward the earth and prevents their escape
Dust coming from the Sun
30 miles
60 miles
Inner layer - Non-conducting Zone in which wireless waves move around the earth
Dust
Earth

DR. FLEMING'S THEORY

The small drawing below indicates how the radio waves move faster in the conducting layer so that they are bent around until they move parallel with the earth's surface.

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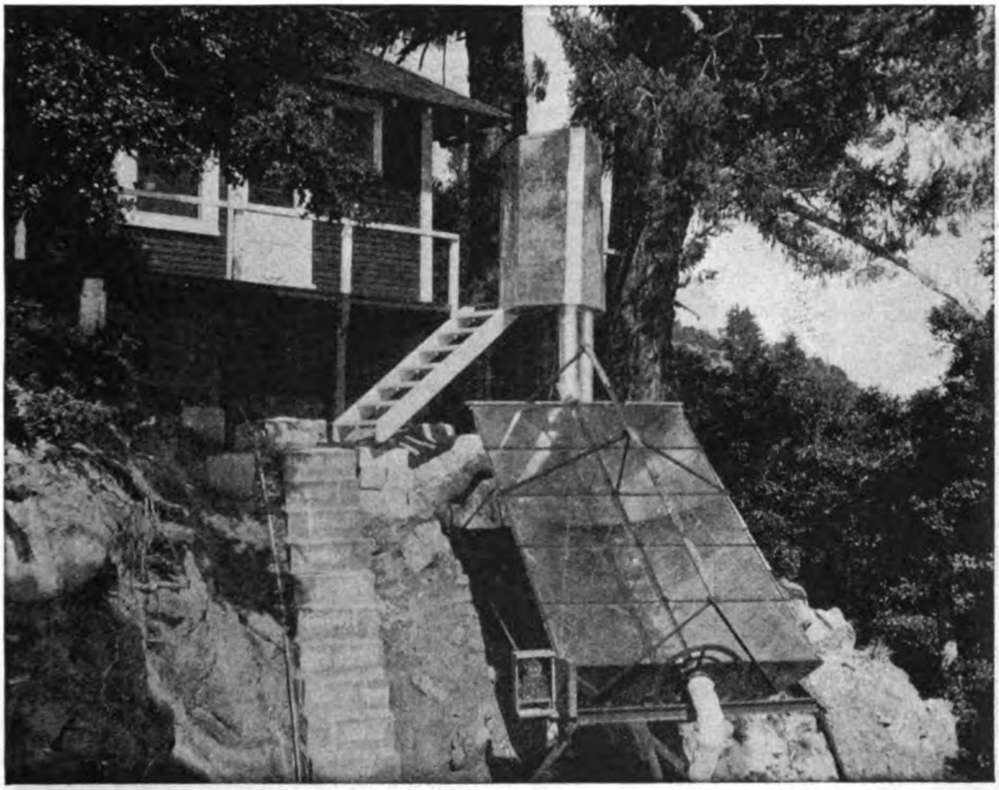
* See Popular Radio for May, 1922.



From a photograph loaned by the Smithsonian Institution, Washington

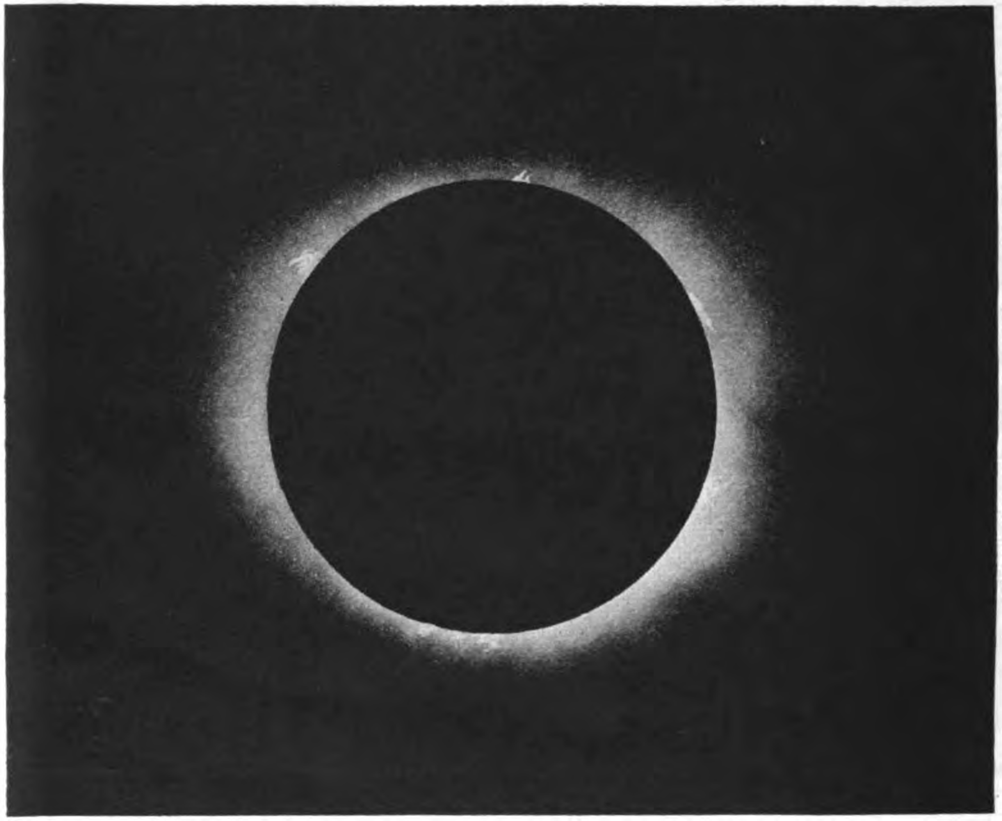
HOW SUN RAYS ARE USED FOR COOKING MEALS

An example of what the scientists call "the utilization of solar energy" is demonstrated in this device that converts sunlight into heat. The same radiant energy that operates this stove drives the solar dust earthward.

hundreds of thousands of miles above it, there is believed to be a cloud of such very fine dust. The particles of this cloud, most of them, fall back slowly toward the sun, to be again melted and vaporized and driven up by other storms into the condensing region where the solar heat begins to yield to the cold of space.

But not all of these dust particles fall back into the sun. Some of them are so small, indeed, that they are pushed farther out from the sun, pushed out by light. This is where the "pressure of light" applies. That light can exert a pressure you can see by observing the apparatus consisting of a glass globe with little metal vanes in a vacuum, common in opticians' windows. These vanes revolve rapidly because the black sides of them, one side of each vane is always blackened, are pushed backward by the effect of light. The pressure of light on very fine dust particles is not exactly the same as this, but it has the same effect. The particle is pushed outward from the sun. If the particle is very small and consequently very light, it is pushed outward with great velocity, perhaps as much as five hundred or a thousand miles per second.

It is believed that such particles are being shot out constantly by the sun in all directions; they are being pushed out by sunlight. Some of these particles reach the earth, or rather the earth's atmosphere. Most of them do not sink to the earth' surface, because they are too small. The earth has a protective blanket of air and very fine particles cannot fall



From a photograph loaned by Lick Observatory, California

WHERE THE "SOLAR DUST" GETS ITS START

This photograph of an eclipse of the sun shows the surrounding glow or "corona," which consists in part of great clouds of vapor and dust hundreds of thousands of miles high. This is the source of the solar dust.

through this. You have seen how dust motes seem to float in a beam of sunlight. Really they are floating in air, or only seem to float; in absolutely still air they will ultimately sink to the ground. They sink very slowly.

These dust motes are many thousands of times larger than the tiny dust particles received from the sun, which will not sink in air at all. They float in it forever, as a cork floats in the sea. High in the air there is a layer of them, thinks Dr. Fleming, a permanent layer, a layer which provides the conducting protective screen about the earth included in the wireless theory.

In a sense this dust-filled layer is the upper surface of the atmosphere, but it must not be thought of as a definite distinct surface, like the surface of the sea. The density of the air decreases as one rises from the earth's surface, but it decreases gradually. The air merely becomes thinner and thinner as one goes up; above five or six miles the air is too rare to support life. Above ten or fifteen miles its chemical composition begins to change. At fifty or sixty miles above the earth's surface the air is unlike the air we know and breathe. It is very thin; by earthly standards it is practically a vacuum. It contains no oxygen and only a little nitrogen. Mainly it is hydrogen and helium, the lightest of known gases. These are the gases with which we fill balloons. And when we do so the balloons start upward, upward toward the brothers of their own family, toward the atmosphere levels where these gases belong.

It is these greatly rarified higher levels of hydrogen and helium which are believed to stop and hold the solar dust particles. Thin and tenuous as the atmosphere is at this level, it is nevertheless sufficient to stop the infinitely tiny dust particles, to prevent them from falling further earthward. And all these particles, coming as they do from the intense electrical disturbances of the sun, are charged with electricity. They create a charged, an electrified layer. An electrified layer of gas is always a conducting layer, one competent to conduct electricity, to stop and reflect the wireless waves.

This forms the wireless screen which Dr. Fleming believes to lie about the earth. The solar dust, all of it electrically charged, is shot out toward us, is caught and stopped by the upper levels of our atmosphere and produces there an electrically conducting layer.

There are, of course, many other details for speculation. The probable thickness of the electrified layer; the separation of positively and negatively charged particles; the possibility of conducting layers or clouds below the main layer, with the relation of these to static; the effects of sunlight and shadow upon this conducting layer.

The essence of the theory is simple. Beneath the conducting layer, in a fifty or sixty mile skin of air between the wireless screen layer and the earth's surface, we operate our wireless. Wireless waves cannot get out. Long distance wireless is possible for this reason. These wireless waves have to stay in this wireless skin about the earth and keep their energy for the receiving station, and not waste it uselessly in empty space.

But, you say, why worry about all these matters of conducting layers and wireless screens? Long distance wireless really works. Who cares *why* it works?

The scientist cares. He cares for the sake of knowledge, even if utility seems improbable. But in this case utility for this knowledge is far from improbable. Understanding some natural phenomenon is the first step toward using it. If we can learn more exactly the nature of Dr. Fleming's wireless screen we may feel pretty sure of being able to use it. For instance, variations in it and in the relating conducting layers or clouds below it probably cause the great differences in wireless range between day and night as well as the differences from day to day or with the seasons. The condition of the screen has much to do, probably, with interferences by static.

Knowledge of just how the screen works, of just how it keeps wireless waves to their proper paths around the earth, will go far to solving one of the greatest problems of practical wireless—the problem of maintaining uniform transmitting conditions for twenty-four hours a day and three hundred and sixty-five days a year.

Then there is another matter. There are proposals that we should try to signal Mars by wireless. If this is tried, how are we to get our signals through the wireless screen about the earth? Such signals would be forced back earthward, just as ordinary wireless waves are. No way of avoiding this difficulty is known, but doubtless the wireless engineers will have learned one by the time the signalling of Mars is actually attempted for new discoveries are common in radio.

¶ *Every experienced radio amateur in the country knows of Prof. J. H. Morecroft, the wireless expert of Columbia University. In the next issue of* POPULAR RADIO *will appear his article (the first of a series), that will treat of a vital function of the vacuum tube —a subject on which Pro. Morecroft is a foremost authority.*

The Law and

Surprising and Important Bits of Information Con-
of Radio Messages—an Article that Every

SOME evening when you are listening in on the radio and you happen to pick up a message that is of peculiar personal interest to you—that may even be about you—but that is specifically addressed to someone else, do not think that the message belongs to you, or that even the substance of it belongs to you. And don't think that you are at liberty to divulge it to anyone else, either, for you are not—legally.

In fact, the law states specifically that such a message does not belong to you any more than another person's mail belongs to you. To be exact section nineteen of the Radio Laws provides as follows:

SECRECY OF MESSAGES

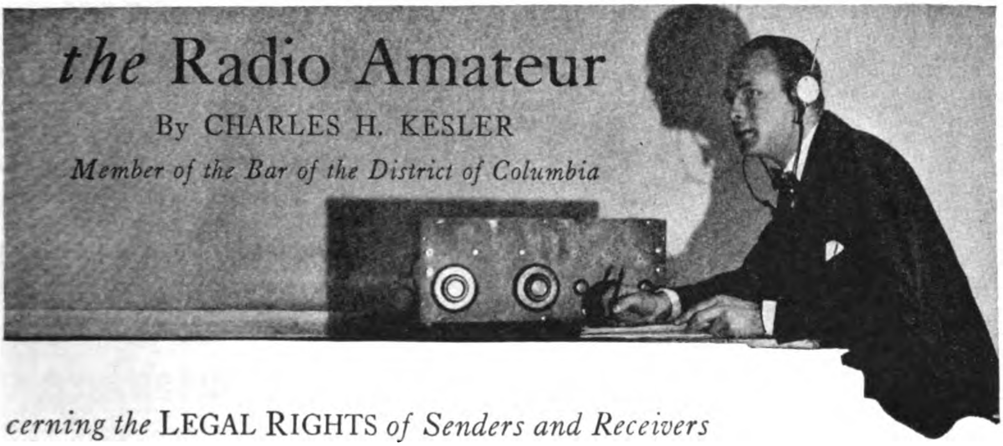
> *Nineteenth.* No person or persons engaged in or having knowledge of the operation of any station or stations, shall divulge or publish the contents of any messages transmitted or received by such station, except to the person or persons to whom the same may be directed, or their authorized agent, or to another station employed to forward such message to its destination, unless legally required so to do by a court of competent jurisdiction or other competent authority. Any person guilty of divulging or publishing any message, except as herein provided, shall, on conviction thereof, be punished by a fine of not more than two hundred and fifty dollars or imprisonment for a period of not exceeding three months, or both fine and imprisonment, in the discretion of the court.

This statute is penal. Its violation upon conviction results in a fine, imprisonment or both, but its violation does not give a right of action by a person damaged against another in a civil action.

Furthermore, this statute, just because it is penal, must be strictly construed. The fact that no decisions involving this statute have been recorded is indeed a compliment to the high moral characters of the numerous persons who have listened in on messages and who have not divulged or published them.

As an example of a possible violation of this statute, for instance, let us assume that the United Press transmitted a news item by radio to the newspaper *Cleveland Leader*. In this case, no one who happened to listen in on the radio message would be at liberty to publish or divulge its contents except to the addressee. On the other hand, if such a news item were broadcasted—that is, if it were not directed to anyone in particular—it would not be a violation of the statute to divulge it.

Again, suppose the Associated Press, which has thousands of members, should broadcast (in a limited sense) a news item not to one paper but to all of its members, the message, even though it did not specify each member by name (which would not be practical), might be pro-



the Radio Amateur

By CHARLES H. KESLER

Member of the Bar of the District of Columbia

cerning the LEGAL RIGHTS *of Senders and Receivers*

Owner of Radio Apparatus Should Read

tected if it were transmitted with a notice like this:

"For Associated Press members only."

Would a person who divulged this message in a newspaper that is not a member of the Associated Press be liable under this statute? Certainly this is a point which would test the argumentative skill of counsel for both the state and defendant.

These are but the first of the many legal problems that the radio is thrusting upon us. And many of these problems concern the radio amateur, both directly and indirectly. Questions of law are being asked that have not yet been answered by the courts. Can I legally use this set or that set in receiving? Can I legally repeat news, lectures, songs, dramas or other information which I receive while listening in? In my business and social relations can I enforce contracts or agreements that I make by radio? Is there any way of preventing by legal action this confounded interference which prevents me from hearing the songs and lectures which are being transmitted?

The users of transmitters also have their problems. What type of transmitter am I allowed to use by law? Where can I establish my transmitter? Can I transmit copyrighted material? What wavelengths can I use? When can I transmit? How powerful may be my transmitter? What kind of information can I transmit? In other words, to what extent can I interfere with the clear reception of the numerous receivers now in use?

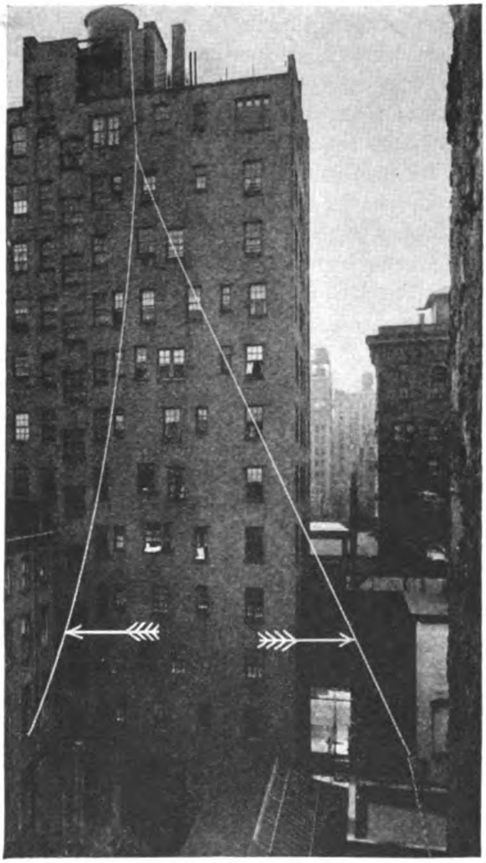
The present radio laws are inadequate to control present radio communication. We hear complaints on all sides about interference and the inability to hear what we want to hear on account of the undesired noises and the conflict of wave with wave. Chaos reigns where law and order should reign. The receivers buzz and grind; music is superimposed on music. A lecture on prohibition becomes entangled with an advertisement for yeast. All this confusion in the ether is due to the very nature of radio communication and to the character of the electromagnetic waves that are transmitted. We can not blame the waves nor can we blame the intelligence behind the transmitters because there is no one to control and regulate them.

Is the problem of regulating all this traffic up to the State or to the Federal Government?

In this country the several states, each of which is a sovereign, have formed a confederation known as the United States of America or the Federal Government. The powers of the Federal Government are designated in and limited by its Constitution. It remains to be seen if the control of radio and the enactment of laws relating thereto be primarily a matter for the Federal Government or for each State.

Article I, Section 8, of the Constitution provides that Congress shall have power:

> To regulate commerce with foreign nations, and among the several states and with the Indian tribes. . . . .
>
> To promote the progress of science and useful arts, by securing to authors and inventors the exclusive right to their respective writings and discoveries. . . .
>
> To provide for the general defense by raising and maintaining an Army and Navy and to provide rules relating thereto.



From a photograph made for POPULAR RADIO

WHEN A "LICENSE" IS REQUIRED

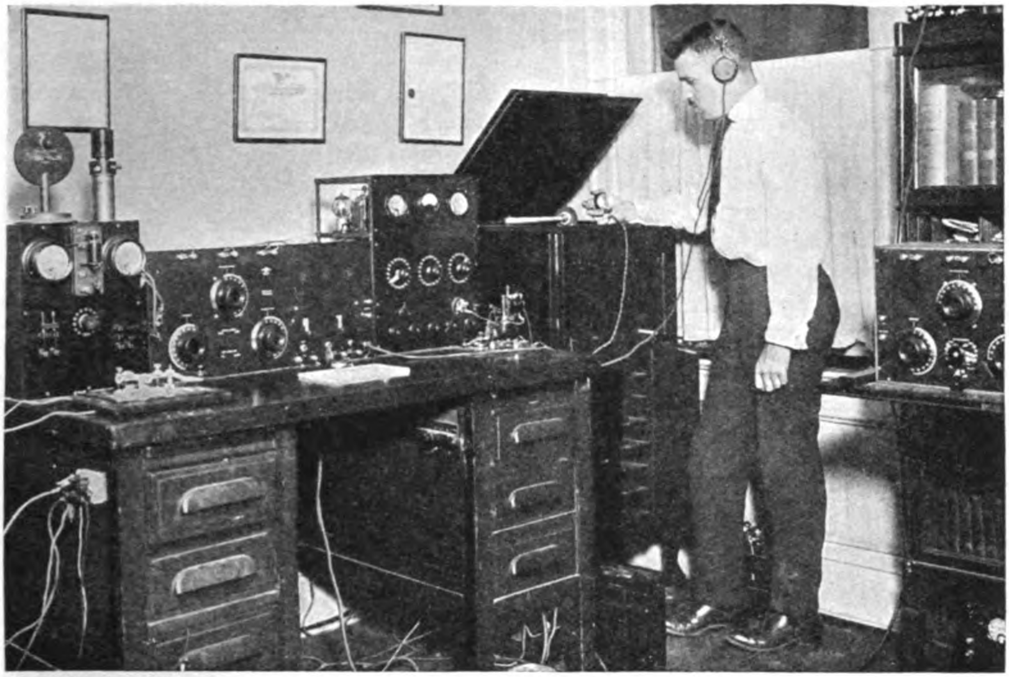
The owner of a radio set has no more right to run an antenna over a neighbor's property than he has a right to run a pipe-line or a railroad over it—until he gets oral or written permission.

As the Federal Government under the commerce regulations clause has assumed legislative control of the railroads and telegraph and telephone lines operating from one State into another and among the several States, so also it has assumed control of and made regulations and laws relating to radio because radio by its very nature is of a character which is bound to extend from one State into another and is of special value in commerce and on the sea.

It is a situation that indeed requires government control and regulation and its necessity arises by reason of the nature of radio communication.

While telephonic conversations and telegraphic messages are transmitted along wires without interference with each other, radio messages are radiated for miles in all directions in space. When several are being simultaneously transmitted, one may and usually does interfere with another. This makes reception difficult unless the wavelengths of the several signals differ. But it should be noted that when hundreds of stations are sending, several of them may be sending on the same wavelength. These invisible waves vary from a few hundred meters to thousands of meters, and the power of the transmitters vary from one-quarter or one-half K. W. to two K. W. and five K. W. and more, whereby the messages may be transmitted a few miles or thousands of miles across States and even across oceans. The interference of one transmitter with another, or (legally expressed) the interference or one person's radio rights with those of another, is clearly within the regulation of the Federal Government.

It is, therefore, within the jurisdiction of the United States to protect the lives of its citizens upon the high seas by requiring the installation of radio sets on ships and providing for the regulation thereof. Again, it is within the jurisdiction of the United States to make such regulations as are necessary to prevent radio transmitters or receivers from



George Grantham Bain

THE BROADCASTING OF COPYRIGHTED MUSIC IS RAISING MANY LEGAL PROBLEMS

Amateurs who have been entertaining their audience gratis by transmitting copyrighted selections have not been "giving public performances for profit." But how about the large, commercial stations maintained by manufacturers and sellers of radio equipment?

interference with each other and with the sets of the Army and Navy. Also, in view of the public and non-secret character of information transmitted by radio, it is within the power of Congress to regulate as to the secrecy of messages and even to protect by suitable copyright laws the music, writings and creations of authors and to regulate the sending of such material by radio for the amusement, information and recreation of the general public.

And, finally, while justly protecting the property and other rights of individuals, it should be the policy of a government of the people, such as ours, to promote the general welfare and happiness of all by such regulation of radio that the use of the thousands of receivers now established may be enjoyed to the fullest extent.

The present radio laws of the United States are found in an Act approved July 23, 1912, amending an Act approved June 24, 1910. These laws are of very little interest to persons who have merely receiving sets and do not transmit. This Act requires the installation of sets on boats, provides rules for their use, and requires licenses of different grades for operators of transmitters, both commercial and amateurs.

But the particular point of law that the Federal Government brings to the attention of the radio amateur—a point so far-reaching in its application as to justify the government in publishing a copy of the law in its post offices—touches upon the ownership of the messages sent by radio.

Consider, for example, the civil side of the question as to who owns the radio messages; that is, of the property rights of one person or organization in news and his remedy against another person who violates these rights. The principles involved here are either of an equitable character or statutory.

News as such is as free as the ether through which it is transmitted. As the word "news" denotes, information comes from the North, East, West and South and is again radiated or transmitted in all directions for the information of man and his intellectual development. Hence it would be against public policy for the state to grant to anyone, persons or organizations, a monopoly on news.

As the rule is proved by its exceptions, so also there arise cases in which the general rule as to news is modified by the courts. We all have the idea of what is just and equitable. So in the relation of man to man, the courts will protect the distribution of news by an organization like the Associated Press, for example, against unfair methods of competition or against the unjust and inequitable methods of a competitor—such, for instance, as causing a breach of trust by an employee or client of the news distributing organization.

One case decided by the Supreme Court of the United States is that of Board of Trade vs. Christie Co. (198 U. S. 236). In that case, the Board of Trade at Chicago distributed grain quotations by ticker to customers under a written agreement to keep it confidential. The Christie Co. by means amounting to a breach of these confidential terms, redistributed these quotations to its customers. The court enjoined the Christie Co. The incident is of interest to the radio amateur because similar principles would apply to radio transmission of news in so far as the facts are approximately the same. The question, however, is rather academic, owing to the non-secret character of radio transmission and the large number of receivers now in use.

News items and ideas are not copyrightable as such. But the literary style or garb in which said news and ideas are expressed is copyrightable. Lawfully copyrighted matter cannot be reproduced or published by an unauthorized person, even though received by radio, unless it is changed into a non-copyrighted form. And this brings up a point of law that sooner or later will affect the broadcast programs that use copyrighted material.

The following classes of writings may be copyrighted: books, periodicals, newspapers, lectures, sermons, addresses, dramatic or dramatico-musical compositions, and musical compositions.

A copyright may be secured by first publishing the work with the copyright notice upon it and then applying to the Registrar of Copyrights for a certificate. In cases when the writing is not to be printed for general sale and circulation (as in the case of sermons and lectures), manuscript copies are deposited with the Registrar of Copyrights.

The copyright not only covers the original work of the author as printed, and gives him the exclusive right to print and sell it, but if it be a musical work, to deliver or authorize the delivery in public for profit. The author also has the exclusive right to make records for phonographs and player pianos.

Thus it is clear that most of the radio listeners can remain in that condition of mental relaxation that is summarized by the expression "I should worry." The liability for infringement of copyrights is on the person who transmits—unless the transmitted material is reproduced unchanged by the listener by publication or delivery in public for profit.

The development of our present copyright laws offers a good example of the lagging of the laws behind material development and shows how difficult it is to protect rights in property by legislation as conditions change. Under the copyright laws in force in 1908, the Supreme Court decided in the case of White-Smith Co. vs. Apollo Co. (209 U. S. 1) that perforated rolls of mechanical piano players reproducing musical selections do not infringe a copyright on the selections. The laws were subsequently amended to include such records and also moving pic-

From a photograph made for POPULAR RADIO

ANTENNAE THAT REACH ACROSS CITY STREETS ARE LADEN WITH LEGAL COMPLICATIONS

Only a franchised company is permitted by law to string an aerial over a city street; permits to do so are not granted to private parties. The wires in the above picture caused a vast amount of trouble in New York before the right to string them up was finally determined legally

ture of films then in the early stages.

Likewise, the present practice of broadcasting music, lectures, and news may soon show that under our present laws certain rights or interests are not properly protected by laws now in force. These laws will then be amended or new laws made.

The laws relating to agreements and contracts made by radio will presumably be the same as now apply to such transactions by telephone and telegraph. Such agreements, in so far as they meet the requirements of the Statute of Frauds of the several States, are enforceable. It may be of interest to a layman to know that, although agreements, contracts and sales are made daily by radio, telegraph and telephone which are otherwise lawful, yet they are not enforceable in a court because certain statutory regulations have not been complied with. That is, the court will not enforce the contract, no matter how many witnesses one may have, unless the transaction is made according to the required form.

Such statutes, known as the "Statute of Frauds," are in force in most States and are based on a similar statute passed in the reign of Charles II in 1677.

Section seventeen of this Statute provides that

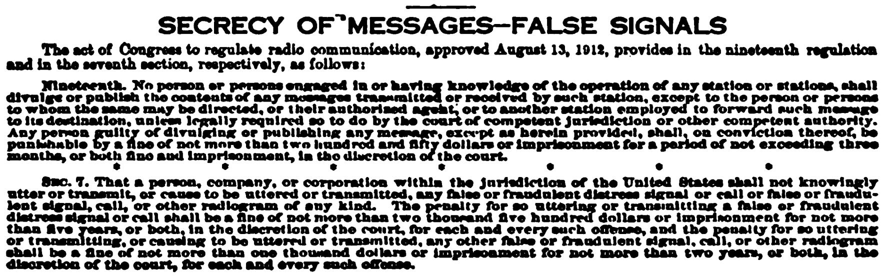
> "No contract for the sale of goods, wares and merchandise above a specified price is enforceable except the buyer accept part of the goods and actually receive the same or give something in earnest to bind the bargain or in part payment or that some note or memorandum of the bargain be made and signed by the parties to be charged or their agents."

Hence contracts of sale made by radio are not enforceable until part of the goods are actually received and accepted by the buyer or until he pays something down or unless there is a written memorandum. Goods can be ordered by radio and when accepted and received the contract of sale is binding. Or money can be transmitted by radio, and the contract of sale would then be binding and enforceable. When the contract is entirely unexecuted a memorandum must be made or such agreements of sale by radio are not enforceable unless they are later ratified in writing. However, countless agreements of sale are made daily by wire or radio in which the parties rely on the honesty and moral uprightness of each other for the execution, even though in a suit such agreements would be unenforceable.

Other laws touch upon the radio amateur—and his neighbor—more directly. For instance, one cannot trespass on a neighbor's property and attach an aerial to his house, barn, tree or other fixture without his consent. One has no more right to do this than to run a pipe or a telephone line or a railroad over his property without his consent. And permission to mount an aerial on property may be given by parol or in writing; such consent is called a license. Licenses are revocable by the owner of the property; they terminate upon the sale of the property and are personal to the parties. When such licenses are granted care must be exercised to mount the aerial properly so as not to cause damage to the property. Under the Statute of Frauds, a conveyance of an interest in land must be in writing. When it is desired to secure permanently the right to install and maintain an aerial on the property of another, a formal deed must be made, conveying the right and interest; otherwise it is a mere license.

Recently in a western state some angry neighbors hauled an amateur into court for allowing his spark transmitter to buzz and sing—as if it could do anything else and work! They claimed that the transmitter was noisy and caused them great discomfort. The judge, however, it appears, was for the amateur and he held that the noise was not a nuisance because it was a noise which we must get used to, even though we do not like it.

The radio laws now in force, although



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NOTICE

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

SECRECY OF MESSAGES—FALSE SIGNALS

The act of Congress to regulate radio communication, approved August 13, 1912, provides in the nineteenth regulation and in the seventh section, respectively, as follows:

Nineteenth. No person or persons engaged in or having knowledge of the operation of any station or stations, shall divulge or publish the contents of any messages transmitted or received by such station, except to the person or persons to whom the same may be directed, or their authorized agent, or to another station employed to forward such message to its destination, unless legally required so to do by the court of competent jurisdiction or other competent authority. Any person guilty of divulging or publishing any message, except as herein provided, shall, on conviction thereof, be punishable by a fine of not more than two hundred and fifty dollars or imprisonment for a period of not exceeding three months, or both fine and imprisonment, in the discretion of the court.

* * * * * * *

SEC. 7. That a person, company, or corporation within the jurisdiction of the United States shall not knowingly utter or transmit, or cause to be uttered or transmitted, any false or fraudulent distress signal or call or false or fraudulent signal, call, or other radiogram of any kind. The penalty for so uttering or transmitting a false or fraudulent distress signal or call shall be a fine of not more than two thousand five hundred dollars or imprisonment for not more than five years, or both, in the discretion of the court, for each and every such offense, and the penalty for so uttering or transmitting, or causing to be uttered or transmitted, any other false or fraudulent signal, call, or other radiogram shall be a fine of not more than one thousand dollars or imprisonment for not more than two years, or both, in the discretion of the court, for each and every such offense.

(TO BE POSTED IN RADIO STATIONS)

So important does the Federal government regard the laws that specify the ownership of radio messages that it posts this warning in the radio stations of the country

THE FEDERAL LAWS REQUIRE RADIO SETS ABOARD VESSELS.
In the protection of the lives of its citizens upon the high sea, it is within the jurisdiction of the government to state what ships shall be equipped with sets and how those sets shall be used.

they regulate the location of transmitters and the wavelengths at which they may be operated, are entirely inadequate to control radio transmission as it exists today. Steps, however, have been taken to clothe the Secretary of Commerce with sufficient authority to effectually control and regulate radio transmission for the benefit of the users of radio receivers.

The first step for the formation of new laws was recently taken by a conference of experts on radio, in Washington, for the purpose of outlining and analyzing the present radio transmitting situation, and to determine how radio communication may be regulated for the purpose of reducing interference to a minimum.

The new radio laws which will be passed will not affect the users of receivers, except to make more enjoyable their use of the radio—unless the listener is using a type of receiver which transmits interfering waves while receiving. When these regulations are in force, offenders who overstep their assigned wavelengths and cause interference will be found and punished by the radio air police.

Other laws that touch the radio amateur are the patent laws. These are not primarily designed for the benefit of the inventor; they are intended to promote general welfare by encouraging the development of the useful arts, giving to the inventor a reasonable compensation for his work or creation. One phase of the patent laws relates directly to the users of receivers. The person who uses an unlicensed receiver that is covered by a patent may be sued for infringement, even though he did not make the set.

The user, however, usually buys his receiver from a manufacturer without a thought of patents; even though he is using an infringing receiver there is very little probability that he will be sued, either because the patentee does not know of the infringement or because the patentee prefers to sue the manufacturer or distributor and thereby obtain larger damages.

It has been proposed that it would be a great scheme to devise a patented transmitter which would send a peculiar wave, capable of being received only by a peculiar and patented type of receiver. The owner of the patent on this apparatus could thus broadcast matter which could be received only by the patented receiver which of course the patentee would sell. All other types of receivers on the market would thus become or be "junk" as far as the new station would be concerned.

As the situation now is, while one manufacturer of apparatus bears the expense of broadcasting to the users of its receivers, yet other manufacturers indirectly benefit by this broadcasting because the users of other types of receivers can also listen in on the broadcasted matter. Is this fair? Presumably it is. As yet no constitutional amendment has been made requiring us to use cotton in our ears.

Should the type of secret broadcaster be allowed by law if it is ever developed? Probably not, as it utilizes a public medium for entirely private ends and may cause interference. The recent conference in Washington resolved as follows:

> RESOLVED, That it is the sense of the conference that radio communication is a *public utility* and as such should be regulated and controlled by the Federal Government in the *public interest*.

If radio communication is to remain or be a "public utility" no monopoly on broadcasting for the benefit of the few could be tolerated.

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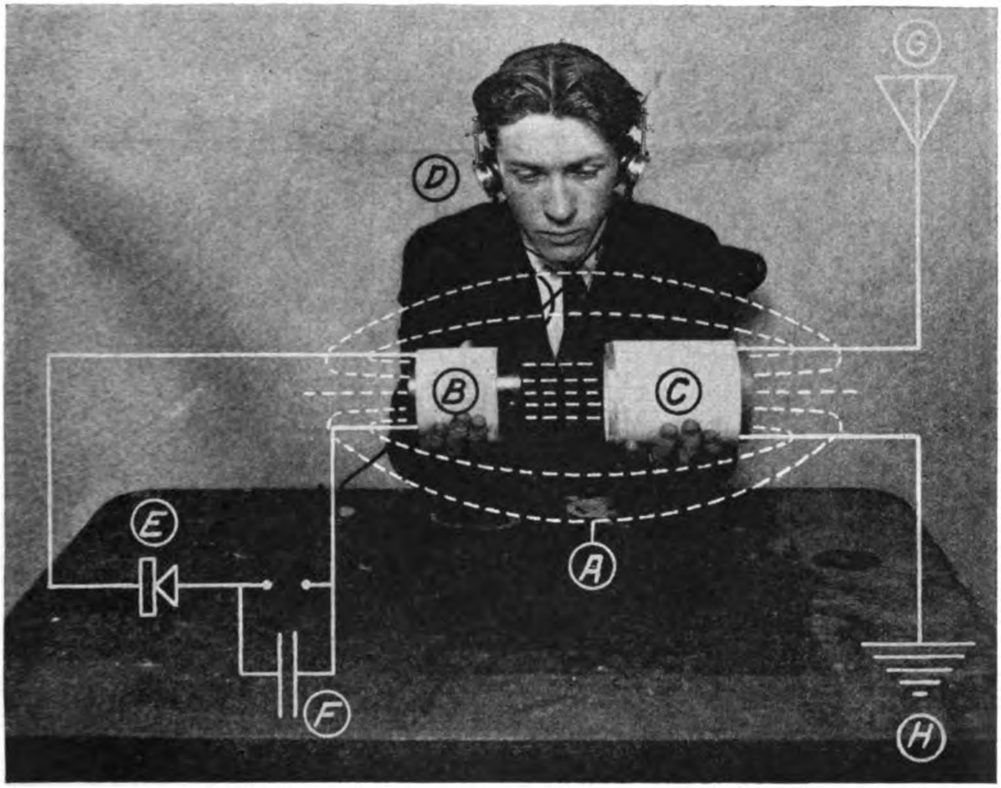
A RADIO SET IN A SAFETY RAZOR BOX

Some day we will consider a pocket radio set as much of a necessity as a watch. Here is another ingeniously devised receiver made by a boy in New York, Sidney Kasindorf, who with the use of a variable condenser, a tuning coil and a crystal detector can hear the big station at Newark without trouble.



From a photograph made for POPULAR RADIO

WHAT THE MAGNETIC ENERGY CIRCULATING AROUND YOUR RECEIVING COILS LOOKS LIKE

If the human eye could perceive lines of electromagnetic force, it would see the phenomenon shown in this diagram. A are the lines of force generated by the primary coil C, which induce currents in the secondary coil B. D are the head telephones; E the crystal detector; F the fixed telephone condenser; G the antenna and H the ground connection.

How Radio Circuits Are Coupled *and* Tuned

Simple "How" Articles for the Beginner—No. 4

By LAURENCE M. COCKADAY, R. E.

RADIO currents of high frequency are usually generated in some form of closed circuit, which is tuned by varying either the inductance or the capacity in the circuit or both. These currents must, however, be supplied to the antenna circuit, in some way or other, before they can be used for the propagation of Hertzian or radio waves through space, thus making possible radio telegraphy and telephony.

The device used for this purpose is called a "transformer." When it is used for transmitting it is usually called an "oscillation transformer," and when used in a receiving set, it is known as a "loose coupler" or "variocoupler."

Before we take up the devices used for high frequency currents, let us study the ordinary low frequency transformer such as is used for lighting our homes.

Such a transformer consists of three

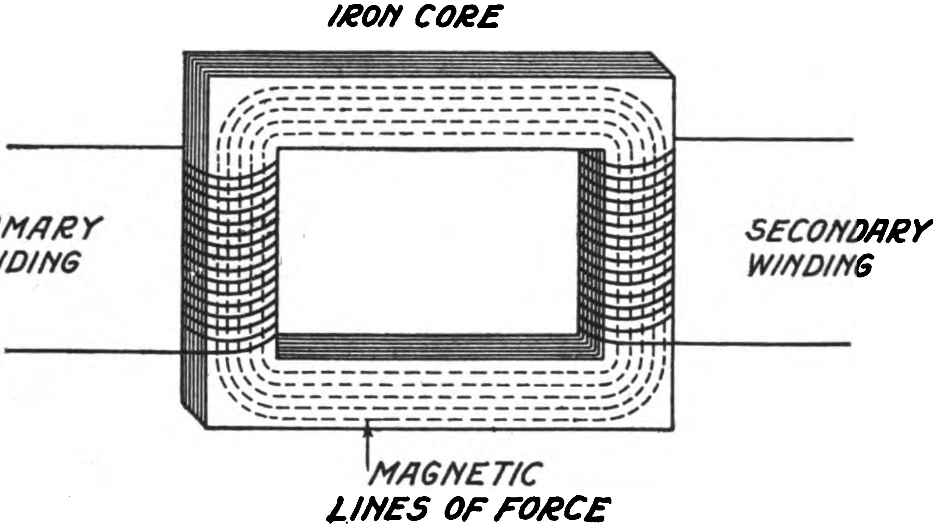


FIGURE 1
How an ordinary transformer transfers electric current from one circuit to another by means of two coils and an iron core.

main parts; a primary winding, a secondary winding, and an iron core. The core is usually made of iron sheets built up in the form of a square "ring," or hollow square. The primary winding is then wound over one side of this square, using the iron for a core, and the secondary is wound over the opposite side of the square, also using the iron for the core. Such a transformer is shown in Figure 1.

Now if we cause an alternating current or a pulsating direct current to flow through the primary winding, by connecting the two ends of the primary wire to an alternating current generator or a direct current generator, with a device for breaking up the direct current into impulses, we will cause the iron core of the transformer to become magnetized. The magnetic flux will flow around through the square rings, and the direction of its flow will be governed by the direction of the current flowing through the primary coil.

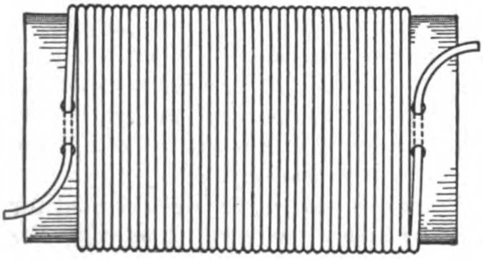


FIGURE 2
A coil of the type used for transferring currents from one radio circuit to another.

We have already learned that if insulated wire is wound on a soft iron core and a current of electricity is caused to flow through the winding, the core will become magnetized. If a similar winding and core were suddenly to be placed near enough to a permanent magnet for the iron core to become magnetized externally for an instant, the reverse action would take place, and a current would thus be induced in the winding.

To return to our transformer; when the core is magnetized by the current flowing through the primary winding, the magnetic flux flows around through the core and passes through the center of the secondary winding. At this instant a current is induced in the secondary winding that corresponds exactly with the current that flows through the primary winding. This effect is called electromagnetic induction. The primary winding changes the electric current into magnetic energy; the core carries the magnetic energy around to the secondary coil, and the secondary changes the magnetic energy back into an electric current.

In this way electric currents can be transferred from one circuit to another without any actual connection between the wires of the two circuits. When two circuits are thus connected together by means of a transformer, they are said to be "coupled" together.

Radio circuits are also coupled together in much the same manner, but the transformers used for coupling radio circuits do not have iron cores. They use air cores. Iron cores are used with low frequency currents, while for high frequency currents air cores are used.

In transformers used for coupling radio circuits, the windings are wound on insulating tubes. Such a coil is shown in Figure 2.

If we take two such coils, one for the primary and one for the secondary and place them end to end as shown in Figure 3A, and cause a radio current to flow through the primary coil, the magnetic field surrounding the primary coil will envelop the secondary coil, passing through it and causing a current to flow through the secondary coil.

If, however, we should place the secondary coil at right angles to the primary coil as in Figure 3B, there will be little or no current induced in the secondary coil as the magnetic flux does not flow in the proper direction through it. In most radio sets, the secondary winding rotates, and by rotating the knob on the set which is attached to this coil, the coupling is varied. The reader will now understand what he is doing when he varies the coupling on his set.

In some sets the secondary coil slides in and out of the primary coil, and the coupling is varied in this way. When the secondary coil is in a position that allows all of the magnetic flux to flow through it, the two circuits thus coupled are said to be "closely coupled," and when the secondary coil is placed in a position that allows little or no magnetic flux to flow through it, they are "loosely coupled." When a transmitting or a receiving set is coupled loosely to the antenna circuit, it sends out a sharper wave or receives with much sharper tuning, than a set that is closely coupled.

An oscillating circuit such as that described in the last article of this series,

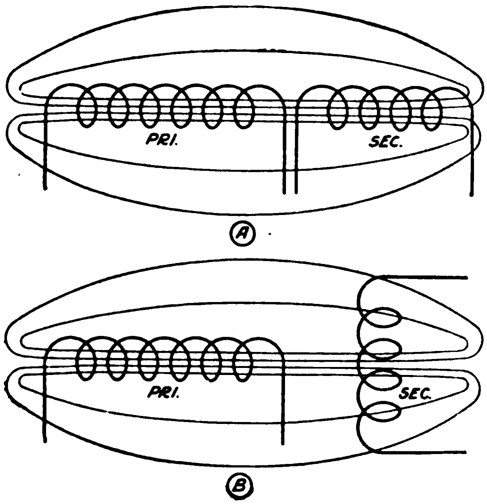


FIGURE 3

A shows two coils placed in inductive relations to each other; large currents are induced in the secondary from the primary. B shows the coil in non-conductive relation. This device is called a loose coupler.

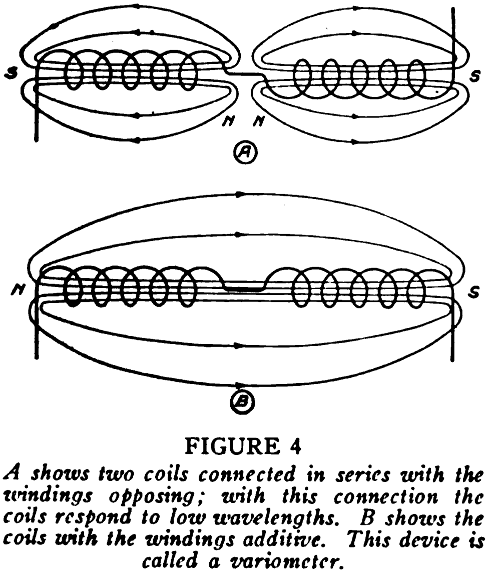


FIGURE 4

A shows two coils connected in series with the windings opposing; with this connection the coils respond to low wavelengths. B shows the coils with the windings additive. This device is called a variometer.

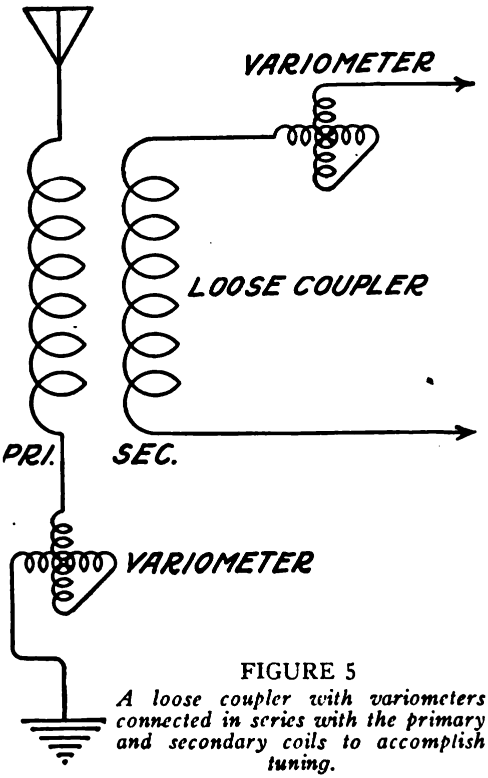


FIGURE 5
A loose coupler with variometers connected in series with the primary and secondary coils to accomplish tuning.

comprises a condenser, a spark gap, and an inductance or coil. The coil serves a double purpose. It tunes the circuit to the desired wavelength, and also serves as the primary coil of an oscillation transformer. The secondary coil receives the oscillations from the primary coil by electromagnetic induction, and at the same time tunes the antenna circuit. The secondary coil is connected in series with the antenna and ground. In this way the antenna circuit is energized and the Hertzian waves are emitted from the antenna.

A variometer, which consists of two coils connected in series, is often used for tuning a circuit. One coil is stationary and is called the "stator;" the other coil rotates inside it and is called the "rotor." In using this device to tune a circuit, when the coils are rotated so that the electromagnetic fields of the two coils are opposing, (as in Figure 4A), the two fields acting against each other do not allow any electromagnetic energy to be stored up, or in other words their mutual induction is theoretically zero.

A coil of this type set in this position would respond to very low wavelengths. If the rotor be turned so that its field be additive with the stator, as shown in Figure 4B, the two fields will act with each other to store up electromagnetic energy, and the mutual induction will be at a maximum. In this position the variometer will respond to a high wavelength.

By slowly rotating the rotor from the first position to the last mentioned position, the variometer can be used for tuning and will pass through the various wavelengths that it is designed to listen in on. The variometer is used for tuning in receiving sets, and Figure 5 shows two variometers used to tune the primary and secondary circuits of a receiving set. The other two coils shown in the circuit are the primary and secondary coils of the loose coupler, or variocoupler.

Thus we see how the coil is used in radio circuits, and that it serves the double purpose of tuning the circuits while at the same time it couples them together, or transfers the electricity from one circuit to the other.

"THE NEWSPAPER THAT COMES THROUGH THE WALLS OF YOUR HOME"

Do you know that at the present time there is a daily newspaper that has no printing press, no plates, no pictures and no type? Its news is sent out to its subscribers by radio. Do you know that there is another newspaper that maintains a radio-equipped motor car that is a licensed sending station in which it sends out its reporters to cover news items in places where telegraph wires are not accessible? Read about these new and strange features of the modern newspaper in the next issue—written by Homer Croy, who (properly enough) comes from Missouri.

From a photograph made for POPULAR RADIO

THE MAN WHO ASSIGNS THE CODE NAMES

His official title is "chief of the Radio Service, Department of Commerce;" his name is W. D. Terrill—known to radio amateurs throughout the country.

What "Call Letters" Mean

By CAPT. WILLIAM E. MOORE

EVERYONE who has ever listened in on the radio—and there are few left who have not—is familiar with the formula that every sender uses when he introduces himself into the world of the ether.

First of all he asks "all clear?" Only he doesn't ask it in exactly those terms. He uses the same expression that the golfer uses; he queries "fore?" Or else he uses the code signal:

" . .   . "

If he finds that he is not intruding upon a conversation; if no one warns him to keep out; the sender then proceeds to call the station he wants by repeating its call letters three times, thus:

"2AQB 2AQB 2AQB."

And then he follows up by identifying himself by his own call letters:

"De2XK 2XK 2XK."

What do these call letters mean? Who assigns them? What do the numbers and letters signify?

The number 2 in both of the above calls indicates that the sending station is an amateur station located in the Second Area. There are nine areas in the United States altogether. The call letters "2AQB" thus make clear the status of the station and its general location; a reference to the booklet, "Amateur Radio Stations of the United States," issued by the Department of Commerce, identifies the sender as William A. Mackay of Coytesville, New Jersey.

The sending station call number indicates that it is also an amateur station and that it is also located in the Second Area. But the letter X marks that station as unique among amateurs, for that letter is reserved exclusively for experimental stations that have special privileges. And the K identifies the particular station within this classification. A reference to the printed list of licensed stations shows that the station is located in New York City and is owned by Laurence M. Cockaday.

Whenever the letters X, Y or Z follows a numeral, the amateur station may be identified as an experiment station, a school or institute, or an amateur radio relay station, respectively.

Similarly, all call letters that begin with W and N belong exclusively to Uncle Sam; the letter K belongs to him only in part. They were first officially assigned to him at an international conference held in 1912, when the letters of the alphabet were distributed among the nations of the world for such purposes. How Uncle Sam makes use of these three letters is his own concern.

This division of the alphabet among the great powers of the world—a division which is still unknown to the masses of the people of the participating nations—began at London on the occasion of the International Radiotelegraphic Conference and was completed at Berne, Switzerland, on the day of the beginning of the World War, August 1, 1914. The London Conference sat to consider the regulation of radio communication between the nations of the world. At that gathering, mandates for international call letters were distributed among the conferring powers.

But the delegates to London made only a partial allotment of call letters to those countries that signed the convention; this work was completed later by the International Bureau of the Telegraphic

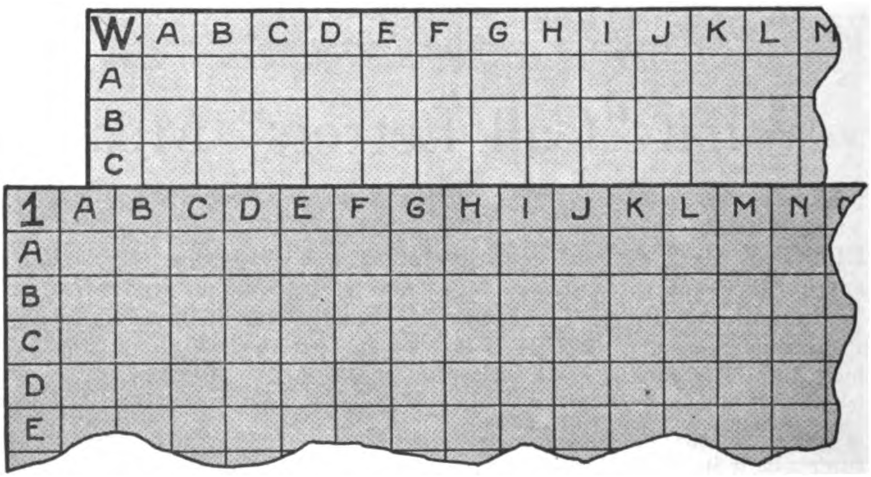


FIGURE 1: THE "W CHART" ON WHICH CALL LETTERS FOR COMMERCIAL STATIONS ARE DETERMINED

In each of the squares is written the name and address of the station to which the call letters are assigned, beginning with the first square, which is designated as WAA. On the chart below the amateurs call numbers and letters are determined, beginning with the call letters 1AA.

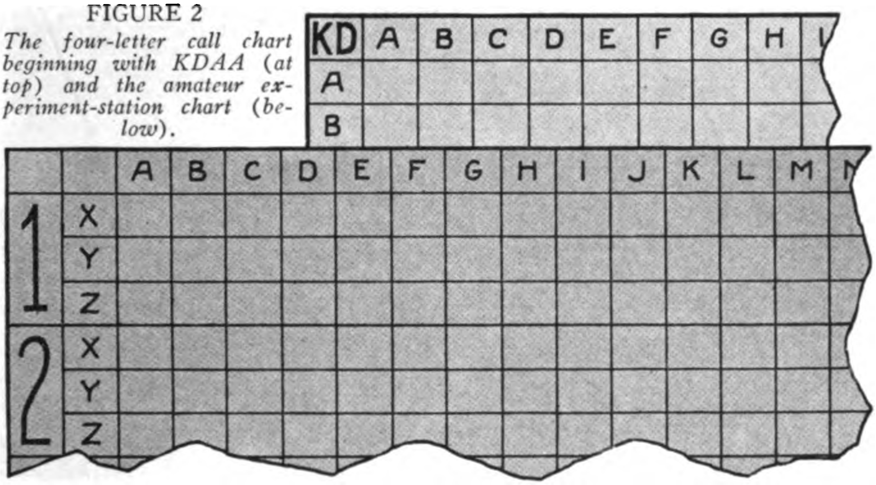


FIGURE 2

The four-letter call chart beginning with KDAA (at top) and the amateur experiment-station chart (below).

Union at Berne, when by the consent of the associated nations it modified and added to the previous allotment of call letters.

The call letters distributed by the Berne Bureau now constitute the basis for every signal that is sent out by a government or commercial radio operator anywhere in the world. That the twenty-six letters of our alphabet can be shifted about to form a sufficient number of combinations to furnish call signals for so many radio stations is at first thought astonishing. But when one considers that the United States of America is getting along without difficulty on something less than three call letters, one realizes that the rest of the world ought to be able to do fairly well on the remaining twenty-three letters.

Thus it was that in the distribution of the alphabet among the peoples of the earth the letters N, W and K fell to the lot of Uncle Sam. This statement must be slightly modified, however, for K is not wholly our own. We divide ownership with Germany.

At this point, perhaps, it should be explained that the service regulations of the International Radiotelegraphic Convention provide that the call letters of stations in the international system must be formed of a group of three letters (now sometimes extended to four) which shall be distinguishable from one another. The call letters allotted to the United States comprise all three and four letter combinations beginning with the letter N, all those beginning with the letter W, and all combinations from KDA to KZZ, inclusive.

The K combinations from KAA to KBZ belong to Germany.

One might think, if he were not broadly informed in matters pertaining to this fascinating new field of communication, that the numerous commercial and government stations in America would quickly absorb all the possible letter combinations beginning with N, W and K. If so, he has another surprise in store when he learns the almost limitless possibilities of combinations within the alphabetical boundaries. In alotting the letters internally the government first turned over the letter N entirely to the Navy Department. Even that does not complete the whittling down process, for the combinations from WUA to WVZ and from WXA to WZZ are reserved for the United States Army. What remains is the commercial allotment.

We have, then, three national sources of control over the distribution of call signals. The Navy Department orders the distribution of signals for the Navy vessels and shore stations: the War

From a photograph made for POPULAR RADIO

A STATION ON THE K CHART GETS A CODE NAME

The country is roughly divided into an eastern and a western section. Commercial stations in the western half are listed on the K chart; the W chart records the stations located in the eastern half of the country.

Department controls certain W groups, and the Radio Service of the Bureau of Navigation of the Department of Commerce has supervision over what remains of the W groups and of those K groups not assigned to Germany. The Radio Service of the Department of Commerce assigns all call signals for amateurs, commercial land radio stations, commercial ship radio stations, and the so-called special stations.

The assignment of call signals to amateur sending stations is in a class by itself, but for commercial radio purposes the United States is divided roughly in halves by the Department of Commerce. West of an imaginary line running north and south through the center of the country each station is given a letter combination beginning with K. East of the central line call signals begin with the letter W. Thus the signal of the Alaska Packers' Association of Clark's Point, Alaska, is KHG, while the call signal of the International Radio Telegraph Co., at Belfast, Me., is WNN. There are some exceptions to the rule, but in principle all Atlantic Coast stations begin with W and all Pacific stations with K.

In order to avoid confusion the assignment of signal calls by the Department of Commerce is recorded upon charts, known as K Charts, W Charts, and District Charts. The latter are for amateurs and specials. These charts are laid off in squares, 27 spaces wide and 27 spaces deep, as shown in the illustrations. Across the top of each chart, beginning in the second column, run the letters of the alphabet in their ordinary sequence. The letter at the top of each column thus indicates every square in the column's depth. Beginning at the second square from the top of the left hand column of the chart the letters of the alphabet range downwards—a letter for each horizontal column. This is a familiar arrangement for code charts, permitting the designation of any square in the chart by means of the letters at the top and side of the intersecting columns. It will be noted that such an arrangement reserves the square in the upper left hand corner of the chart for the first call letter.

On such a chart, then, (Figure 1) the square in Chart W at the point of intersection of vertical column A and horizontal column A would be indicated thus: WAA. If it were desired to indicate the square similarly located on Chart K, the symbol would read KAA.

Suppose the Smith Manufacturing Co. enters an application for a radio license and asks for the allotment of a call signal for its station. Assume that the Smith Manufacturing Co. is located on the Atlantic Coast and is the first applicant to the Department of Commerce for a call signal. If a license is granted, after inspection, the name of the company is written in the square on the W Chart where the vertical column A intersects the horizontal column A. The company is then notified that its call signal is WAA. As long as the Smith Manufacturing Co. retains its government radio license its name remains in the WAA square as a record at the Department of Commerce. Should it give up its license the call signal would be reassigned to another license holder in Atlantic territory whose name would be written into the square WAA.

When the government runs out of three letter combinations, as it has in some instances, the process of doubling the call letters begins. This is indicated on the Department of Commerce charts by dropping a two letter symbol into the upper left hand square, as shown in Figure 2.

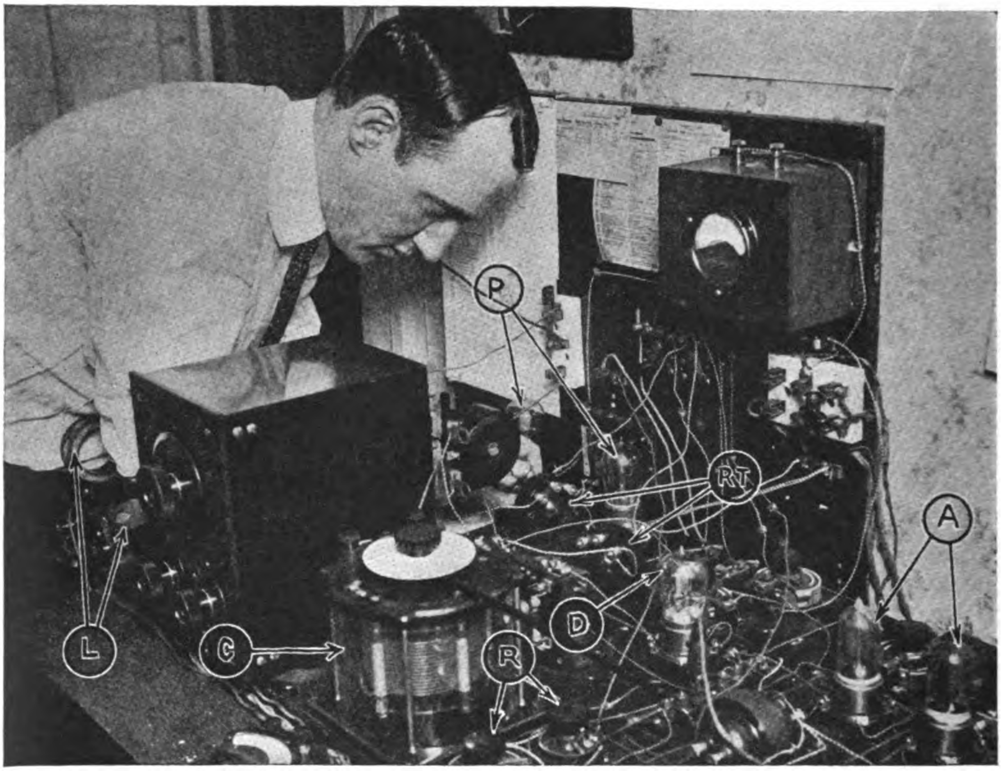
In handling the allotment of call signals to the 15,000 or more amateur transmitting stations in this country the government employs a different system, disregarding the international alphabetical list of call letters. For greater ease in handling the volume of amateur business, as every amateur knows, the Department has divided the country into nine districts. There is a radio inspector in each of these districts who handles directly the applications of amateurs for licenses and call signals. Whenever a license is granted the call signal follows automatically.

The radio inspector gives the amateur a numerical call number instead of an international call letter. This number corresponds with the number of the district. The First District, for example, comprises all the New England states. The charts for that district are known as No. 1 Charts, a diagram of which is shown in Figure 1. The numerical charts are laid off in alphabetical columns in the same manner as the international letter charts.

Mr. W. E. Heckman, of Auburndale, Mass., for instance, appears to have been the first applicant for a license and call signal in the First District, so we find that his call signal is 1AA. The latest recorded applicant in the New England territory is Henry M. Wallingford, of West Somerville, Mass., and his call, being far down the alphabetical list, is 1WZ. The University of California Radio Club, at Berkeley, is in the Sixth District; its number is 6BB.

As the experienced amateur knows the identity of a radio station becomes so intimately tied up in its call letters that it is hard to think of the sender by name.

William A. Mackay is not generally known by that name to his radio amateur friends; some of them, indeed, may never have heard his name at all. He is "2AQB."



From a photograph made for POPULAR RADIO

TESTING OUT NEW AMPLIFICATION CIRCUITS

In this experimental hook-up L shows the honeycomb coils; C the tuning condenser; R the two filament rheostats; D the detector tube; P the radio frequency amplifiers; A the audio frequency amplifiers, and RT the radio frequency amplifying transformers.

THE LATEST DEVELOPMENTS IN

Radio Frequency Amplification

How It Is Being Used For Strengthening the Reception of Weak Signals Without Materially Increasing Strong Signals and For Reducing Static

By ARTHUR H. LYNCH

THERE are two distinct kinds of amplifying circuits used for radio receiving. The first (which is the more common), is called "audio frequency amplification" because the currents that pass through the various units vibrate at comparatively low frequencies within the range of audibility. These currents when passed through the windings of a telephone receiver magnet cause the telephone diaphragm to vibrate in synchronism with their own vibration. Amplification of the audio frequency character is used where the building up of an energy sufficient for the production of a loud signal is desired. The second kind is called "radio frequency amplification."

Radio frequency amplification is designed to fill an entirely different need and its use should not be misunderstood. Radio frequency amplifiers should not be used alone when a loud signal is desired. They should be used to build up the weak impulses from the receiving antenna circuit in order that the detector tube may function satisfactorily.

In vacuum tube receiving circuits (or in crystal receiving circuits for that matter) the detector tube or crystal, as the case may be, operates as a rectifier, permitting current to pass through it in one direction and refusing to permit it to pass in the opposite direction. This rectifier action changes the rapidly vibrating electrical waves that are picked up by the receiving antenna into pulsating vibrations of lower frequencies which may be transformed into sound waves through the functioning of the telephone receiver.

The operation of a crystal or vacuum tube detector depends upon a number of varying features, not the least of which is the natural condition of the mineral or crystal itself, and the energy of the incoming signal. In order to have any type of detector operate satisfactorily as a rectifier the incoming signal should be rather strong. Of course strong signals, as they are understood today, are entirely different from the strong signals of the past.

When receiving outfits are located near a radio broadcasting station, ample signal strength may be secured by the use of the detector alone and this comparatively strong signal may be built up by the use of audio frequency amplifiers to sufficient strength to operate loud speaking devices —providing an outdoor antenna is used. If the receiving station is more remote and the signal weaker, however, it is necessary to build up the incoming signal by means of radio frequency amplification. This building up is done satisfactorily by the methods described here.

There are certain limits to the value of radio frequency amplification. Once the signal from a transmitting station has been built up to a certain point, increasing the number of stages of this type of amplifier does not result in an increase of the signal strength. For this reason it is possible, when radio frequency is employed, to build up a weak signal without building up a comparatively stronger signal in the same proportion, permitting the operator to copy the weaker signal and reduce the interference from the stronger station, within fixed limits.

When radio frequency amplification is applied to a loop or frame antenna, it provides, even with this small energy ab-

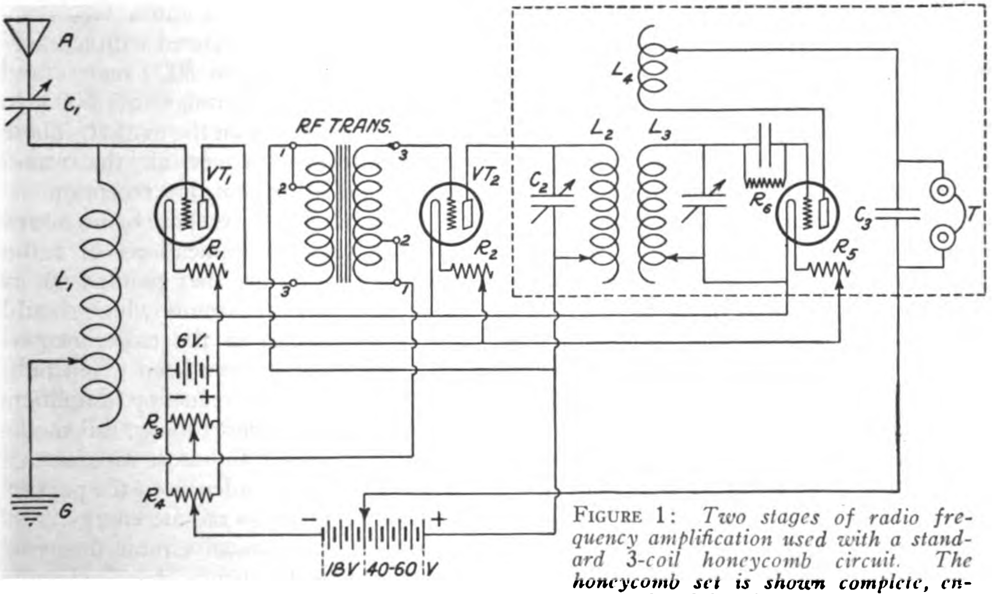


FIGURE 1: *Two stages of radio frequency amplification used with a standard 3-coil honeycomb circuit. The honeycomb set is shown complete, enclosed by the dotted lines.*

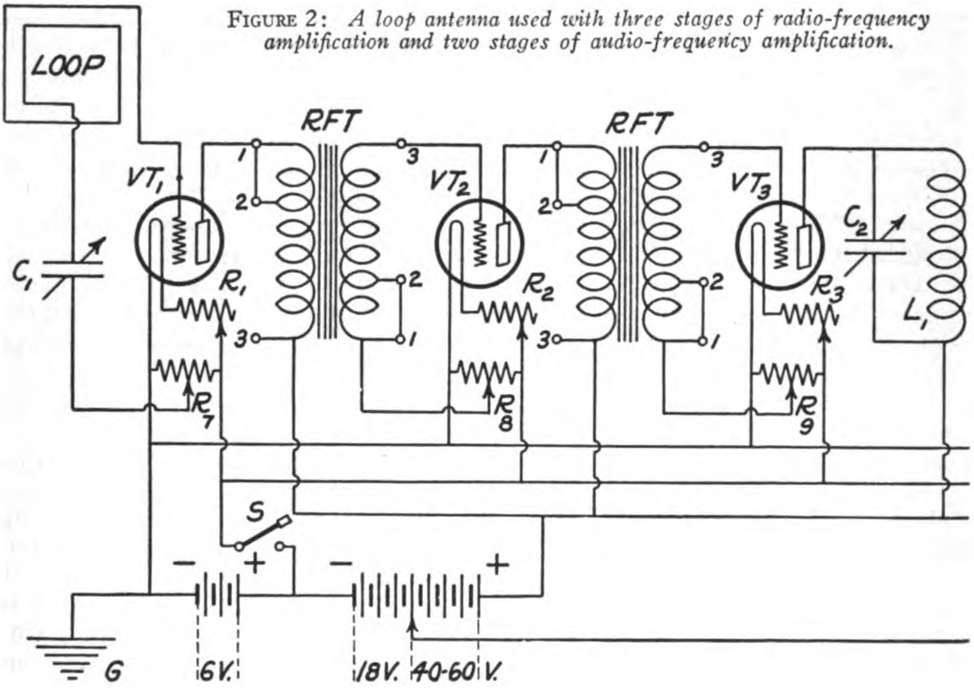


FIGURE 2: *A loop antenna used with three stages of radio-frequency amplification and two stages of audio-frequency amplification.*

sorber, an intensity strong enough to actuate the detector tube over comparatively long distances. By the addition of audio frequency amplifiers this signal may be built up to a strength sufficient for the operation of a loud speaker.

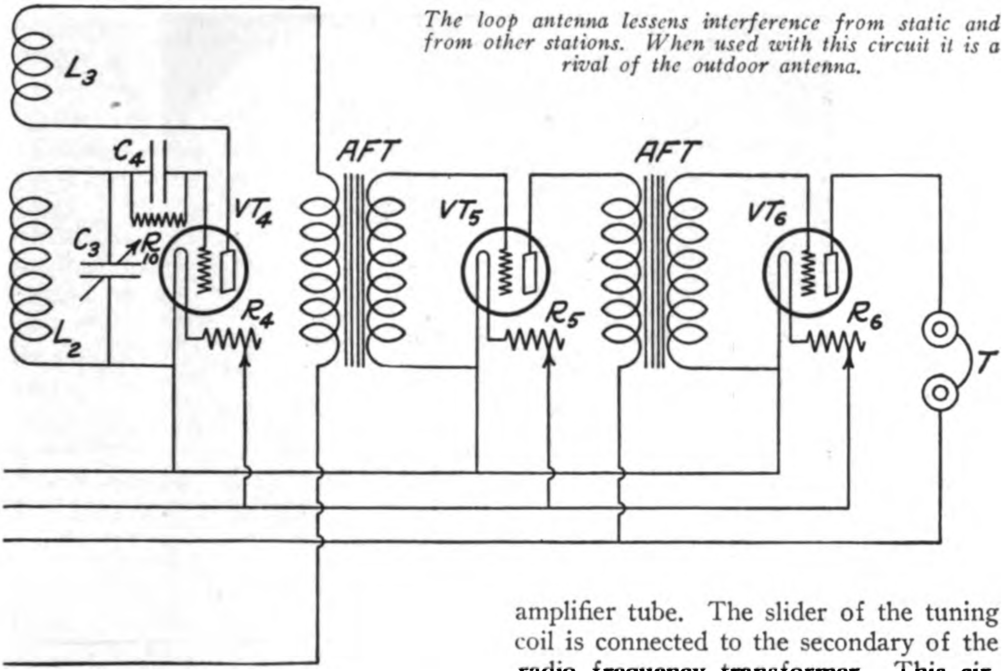
When more than two stages of audio frequency amplification are employed there is a tendency for the signals, especially if they are radio telephone signals, to become distorted and sometimes unintelligible. For this reason it is generally more advantageous to employ enough radio frequency amplification to permit the proper operation of the detector, adding not more than two stages of audio frequency amplification to produce a loud signal.

Where radio frequency amplifiers are used in conjunction with a suitable loop antenna and timing elements, two or three stages in cascade permit the copying of European stations.

Heretofore, when radio frequency amplifiers have been employed, it has been found that their use involved transformers of different designs for the different ranges covered by the receiving set, so that in order to cover a wavelength range of 200 to 5000 meters two or three transformers were necessary with each stage of amplification. If three stages were employed it necessitated the use of six to nine different transformers. Today this is not necessary, for a radio frequency transformer may be secured with a wavelength range of 200 to 5000 meters and another covering a range of 5000 to 25,000 meters is now on the market. These two transformers cover all the wavelengths used in present-day reception.

The circuits illustrated here by no means cover the various applications of radio frequency; rather are they pointed out as typical of a class of circuits which should suggest themselves to the experimenter. Some circuits that have been given publicity show radio frequency amplifiers used with single circuit tuners; this method, however, is not the most satisfactory because there is a tendency on the part of the receiving outfit to radiate energy.

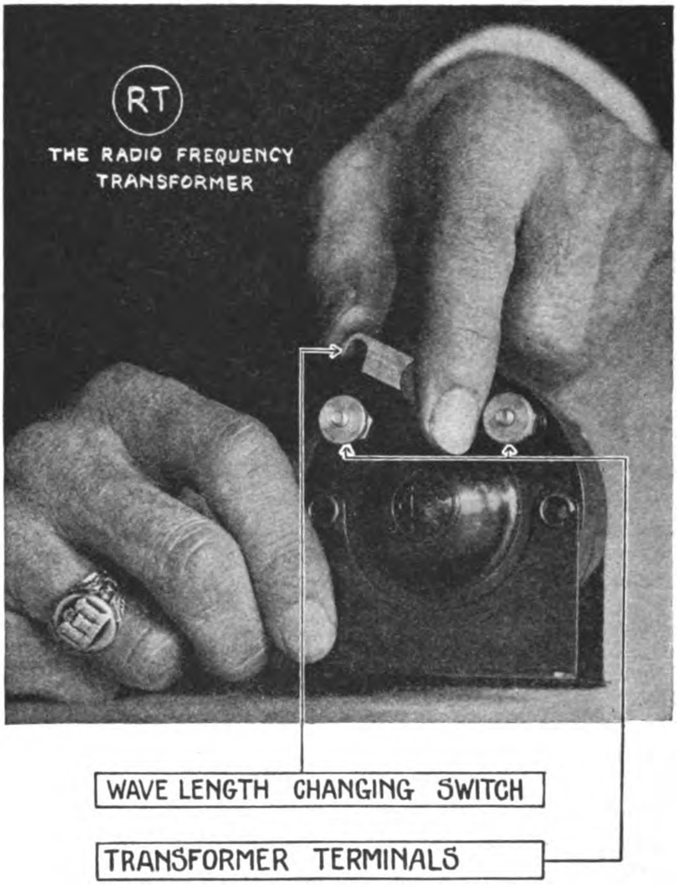
Figure 1 is a typical circuit that employs one radio frequency transformer in conjunction with a standard regenerative



The loop antenna lessens interference from static and from other stations. When used with this circuit it is a rival of the outdoor antenna.

receiving circuit. The regenerative receiver itself is enclosed by the dotted lines. It will be noticed that two radio frequency amplifying tubes are employed; this is done because the first tube is used in conjunction with a standard radio frequency transformer, with a wavelength range of 200 to 5000 meters, while the second amplifying tube is connected in the primary circuit of the loose coupler or vario coupler used in the regenerative receiver. This primary, instead of being connected to the antenna and ground systems as is ordinarily the case, is shunted by a variable condenser. In this case the primary with its variable condenser and the secondary with its variable condenser, form the primary and secondary of one stage of tuned radio frequency amplification.

The difference between this circuit and most regenerative receiver circuits, therefore, is found between the antenna and ground systems and the vacuum tube detector. A variable condenser C1 is connected in series with a single slide tuning coil between the antenna and the ground. One end of the tuning coil is led directly to the grid of the first radio frequency amplifier tube. The slider of the tuning coil is connected to the secondary of the radio frequency transformer. This circuit acts as an energy absorber and the small currents picked up by it are amplified through the two stages of radio frequency before they are passed to the secondary tuning circuit and the vacuum tube detector. It should be noted that in this circuit two standard "A" battery potentiometers are employed; one of them is used to regulate the plate potential of the detector tube and is shunted across the "A" battery with its movable contact in series with the plate battery, to which connection is generally made at the 18-volt tap. This potentiometer is indicated by "R4" in the diagram. "R3" is another standard "A" battery potentiometer, similarly shunted across the "A" battery with its movable contact connected to the antenna absorbing circuit and the secondary of the first radio frequency transformer. The potentiometer in this instance acts as a stabilizer and its proper manipulation results in eliminating undesirable noises which would undoubtedly occur without it. The values of the various instruments can be easily determined by experiment, however the values of capacities and inductances for long waves



must necessarily be increased materially.

Figure 2 shows a method for using a loop antenna with several stages of radio frequency amplification and two stages of audio frequency amplification. For ordinary broadcasting reception or amateur reception a satisfactory loop antenna may be made by winding five or six turns of lamp cord (untwisted) upon a frame three feet square and about six inches wide, No. 14 B. & S., spacing each turn one-half inch between wire centers and providing a tap on each turn for regulation on the inductance of the loop.

With a circuit of this character, employing as it does three stages of radio frequency amplification, a signal of slightly greater intensity is obtained than is possible with an average outdoor antenna and the detector tube alone. This arrangement, however, is susceptible to little interference because of the very marked directional characteristics of the loop, which will respond to signals from a given direction only; that is, the direction in which the loop points. Interference from various transmitting stations as well as static is materially reduced where a loop antenna is employed. The action of the audio frequency part of the circuit is similar to audio frequency applied to practically any other circuit and is merely used for the building up of great enough signal intensity to actuate a loud speaker.

In loop reception it may be readily seen that a number of stages of radio frequency are necessary for bringing about the same result which would be possible with a single detector tube and an outdoor antenna—except for the fact that the outdoor antenna is much more liable to interference from undesired stations as well as natural electrical disturbances.

Where a radio frequency amplifier of this character is built, the experimenter should be sure that each stage is shielded individually, either by a metal box or a box lined with metal (not iron or tin) suitably grounded. With this arrangement the stability is greatly increased when the negative side of the filament lighting batteries is also grounded.

Figure 3 is almost identical with Figure 1, with the exception that the regenerative receiver is of the vario coupler and twin variometer type and the energy-absorbing circuit is equipped with a multi-point switch rather than the slider used in Figure 1. As this arrangement functions almost identically with the arrangement shown in Figure 1, no further explanation is necessary.

There is probably no other form of circuit that will give the amateur such a clear insight into the functioning of the vacuum tube, or give him such an understanding of the characteristics of the tube, as the radio frequency amplification circuit. This is especially true if he builds for himself an experimental set. In tuning such a set and adjusting the potentiometers controlling the grid potential, he will soon find out the true action taking place within the vacuum tube, and rediscover the importance of the grid in the correct functioning of this greatest of all radio instruments.

The proposed set should first be set up on a table and experimented with until the operation of the different circuits are fully understood. The set can then be more easily designed.

In conclusion it may be said that radio frequency circuits of the character shown here have proven satisfactory and have made possible the reception of radio broadcasting concerts over long distances with a minimum of interference. It may be well to remark, however, that circuits that employ radio frequency are slightly more difficult to adjust properly than are circuits in which this type of amplification is not employed. The experimenter is therefore advised not to expect to obtain the best possible results until he becomes rather familiar with the manipulation of his amplifier circuits.

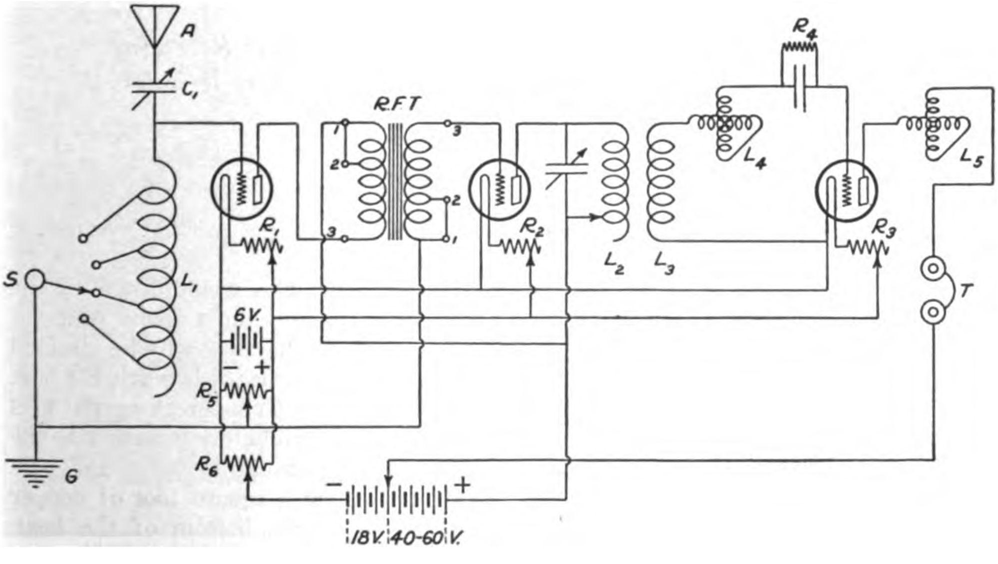


FIGURE 3: *Two stages of radio frequency amplification used with a standard two-variometer regenerative circuit. A tapped tuning coil and a variable condenser are used for tuning the antenna circuit.*

Brown Brothers

A CROSS-THE-CONTINENT RECEIVING STATION

With a loop aerial (which may be less than a foot in diameter) and with but a single radio-frequency amplifier, signals may be received over hundreds of miles; with additional stages of amplification signals may be received for thousands of miles.

Radio on Your Pleasure Boat

Some of the Ingenious Ways for Installing Your Receiving Set on Small Craft that will Enable You to Enjoy Wireless Programs on Your Vacation

By PAUL McGINNIS

WHEN the owner of a modern pleasure boat breaks away from the city for a cruise, he has a host of ethereal friends to entertain him. He no longer fears the weather man, for although a fog can shut out the scenery and a rain can make him seek cover, his radio receiver makes his trip a successful vacation.

In fact, one motorboat enthusiast who takes religious care of his engine and would rather see a good coat of paint on his boat than a stylish coat on his back recently remarked that the first consideration in planning a cruise was his radio set. His immaculate boat was of secondary importance.

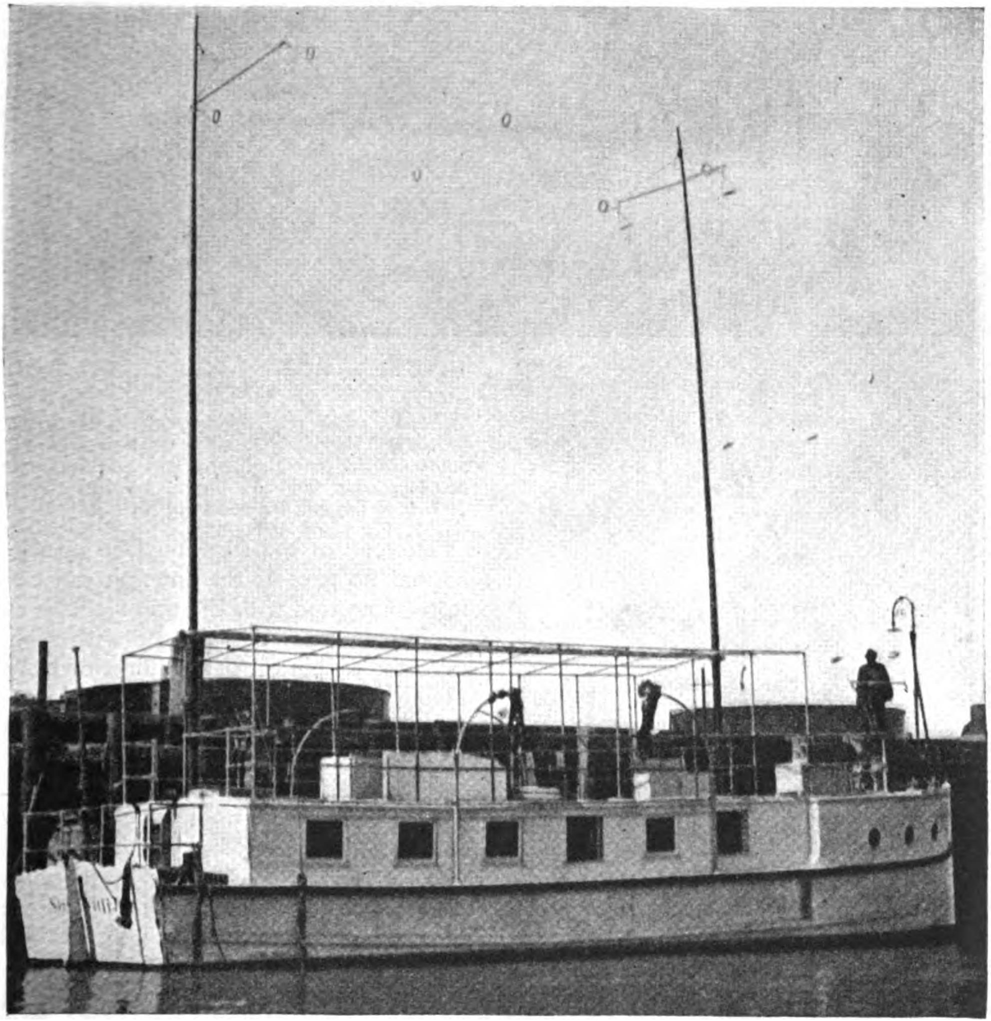
He was one who would listen to the purr of his engine like a piano tuner at work. Perhaps that was why he strained in many peculiar shapes beneath his boat to place a strip of copper along the keel from stem to stern before it went into the water for the season.

He knew that a square foot of copper plate, fixed to the bottom of the boat, would serve all practical purposes, especially in salt water, but he knew also that naval vessels had been equipped with the strip of copper to form the ground connection, and he wanted the best.

"I might strike a heavy sea which would throw a small plate out of the water," he explained.

Some who have smaller boats or canoes, or who take apparatus from their homes to use temporarily on their boats, have found it more convenient to drop some kind of metallic weight into the water to make a ground connection. Where the weight has a foot or more of surface exposed to the water, it has proved itself fairly efficient. In some cases the propeller has formed a fairly good ground when the ground wire has been connected to the engine.

The trailing wire form of antenna has perhaps been the most valuable recent development in using radio sets on small boats. An insulated wire dropped over the side of the boat has been made to work quite as well as the expensive type strung between masts.



International

MASTS MAKE EXCELLENT ANTENNAE

On this pleasure launch the "masts" are merely aerials; the antenna wires are strung between them and connect with the prow. Such an arrangement gives a small vessel the same radio range as an ocean-going liner.

Photos by Edwin Levick

AT SEA—BUT IN TOUCH WITH HIS OFFICE

With a square foot of copper attached to the bottom of the yacht to serve as a ground and a single-masted aerial, Col. Hugh C. Willoughby has long used the "Sea Otter" as both a receiving and transmitting station.

The end of the wire must be insulated so that no part of the antenna can come into connection with the water. This can be done by wrapping the end with rubber tape and dipping it in paraffine, or by applying two patches used to mend inner tubes for automobile tires. Rubber covered wire will last longest in the water.

The boat need not be in motion when the trail antenna is used, as it will receive the radio impulses when hanging straight down from the boat. Deep water is not necessary, for the wire may be allowed to rest upon the ground. A practical length is 75 feet.

The T type or the inverted L type of antenna, strung between two masts, is the ideal arrangement, but almost as good results have been obtained with an aerial brought down from a single small mast of the kind commonly built upon motorboats or small yachts.

About the famous Belle Isle, near Detroit, Mich., the phonographs on canoes have found rivals in radio sets and broadcasted programs. The custom of hearing music on the water while the relaxing business man reclines on soft cushions and paddles his canoe silently through canals and under rustic bridges has received a new impulse with the coming of radio.

The canoe is often a most efficient receiving station, and when smaller boats are made, they will also be stations when they reach the hands of the inventive American amateur.

The trail antenna is valuable to the canoeist, but other types are used successfully. When the canoe is equipped with a sail, the aerial problem is solved by a simple arrangement on the mast.

Perhaps the most successful type for the canoe is the loop antenna, consisting of about a dozen turns of wire around a frame some three feet in diameter. If the skipper of the canoe is a good navigator and can determine his bearings, the loop can be pointed in the direction of the desired sending station, when it will not only tune out other stations sending at the same time, but pick up less static interference than any other form of antenna.

Another form of loop antenna has been successfully made by running an insulated wire along the sides of the canoe and along the keel. With such an antenna, one end of the canoe must be kept pointed directly at the station.

The loop antenna has great possibilities when used with vacuum tubes. With two stages of audio-frequency amplification and several stages of radio-frequency amplification, a loop much less than a foot in diameter can pick up stations in Europe.

A visit to the boat clubs of the Hudson River shows that there are two classes of member, those who have equipped their boats with radio and those who are planning to do so. Even the commodore of the rockingchair fleet, that aged person who is a sailor only in spirit and who rocks in contentment on the club veranda, is either enjoying the clubhouse radio receiver or starting an agitation to install one.

A TINY STATION—BUT IT WORKS

This compact little outfit both receives and sends radio messages. The power is furnished by four dry cells; the trailing antenna is dropped over the side of the canoe on the left.

Complete transmitting apparatus is sometimes condensed into such a small form that it can be operated in a canoe or rowboat with the aid of dry cells.

Receiving sets, practical on small pleasure boats, need not take up more room than a camera. With a simple aerial and ground connection, such a set can pick up transmitting stations more than twenty-five miles away.

Smaller receiving sets are found practical in the race among amateurs for the invention of the smallest, and while the canoeist can carry his in his vest pocket, it is quite likely that the bather will soon have a set for the breakers.

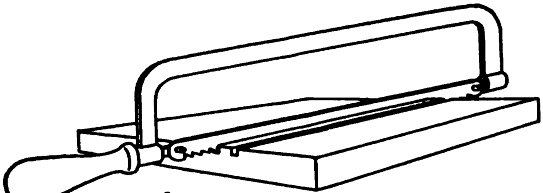


FIG. 1

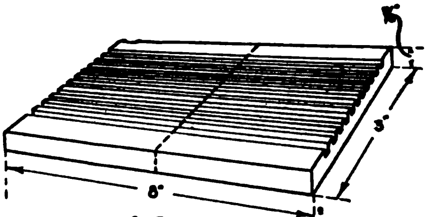


FIG. 2

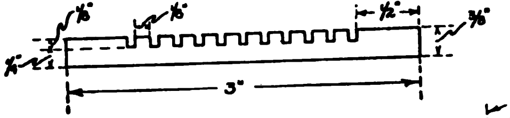


FIG. 3

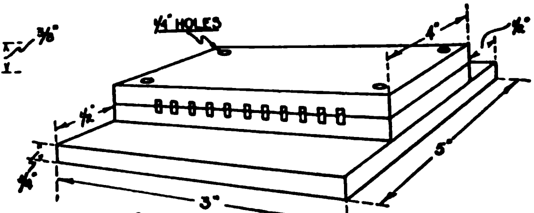


FIG. 4

How to Make a VARIABLE CONDENSER

Simple and Easily Understood Directions for Building This Useful Device at Home at About Half the Cost of a Ready-Made Instrument

By A. HYATT VERRILL

ONE of the most useful instruments used in radio sets, whether of the crystal detector or vacuum tube type, is the variable condenser. Unfortunately these devices are expensive and many beginners are prevented from experimenting with them and from improving their sets because of the additional cost. But an efficient variable condenser which will serve every purpose for the average set may be made at home at a cost of less than half the price of a ready-made instrument. No particular mechanical skill or technical knowledge is necessary to construct this condenser, but if it is to prove successful and satisfactory the fan must expect to take some pains with the task and to work accurately.

If you own a hack saw, a screwdriver, a bench vise, a 1/8-inch drill, a pair of tin shears or ordinary strong scissors you will not require any other tools, although you will be able to do a little neater job and may save a few pennies if you have a set of small screw taps and dies and a soldering set. The supplies you will need are:

A piece of Bakelite or some similar insulating composition about 3 inches by 8 inches in size and 1/8 of an inch thick:

A piece of wood, Bakelite, or fibre 1/4-inch thick and 3 inches by 6 inches in size:

Sheet aluminum 1/32 of an inch thick and large enough to give you 11 pieces, each 2 inches by 3 inches in size:

A small piece of 1/32-inch or 1/16-inch brass about 1/2-inch wide and 2 inches long:

Two binding posts (those from an old dry battery will do very well):

Nine or ten washers for 1/8-inch screws, 5/32-inch thick. If you cannot secure exactly this thickness have a tinsmith cut them from sheet copper or brass of the right thickness or else get some ¼-inch and some 1/32-inch washers and use these together to make up the 5/32-inch required:

Three ⅛-inch brass screw-headed bolts, 1¼ or 1½-inches long, with nuts:

Four ⅛-inch brass screw-headed bolts, 4¼-inches long with nuts. If you cannot obtain these, get ⅛-inch brass rod and either thread the ends yourself or have it done at the nearest garage or machine shop.

The first step is to mark off carefully eleven parallel double lines on the piece of Bakelite 3 inches by 8 inches in size. To do this accurately you must use either a straight edge and a pair of dividers or T-square or a right angle triangle, as the entire efficiency of the condenser will depend to great extent upon the care and accuracy with which you do this.

Draw a line ½-inch from the 8-inch edge of the Bakelite, running the line the length of the block. Then, exactly 1/32 of an inch from this draw another line, or if you prefer, scratch the lines with a sharp steel point.

Exactly ⅛ of an inch from this second line draw a parallel line and 1/32 of an inch from this draw another line. Continue in this way until you have eleven of the double lines each 1/32 of an inch apart and with each pair of these separated by a space of ⅛ inch.

Now comes the most difficult part of the entire operation, cutting grooves or notches where the 1/32-inch spaces are marked. However, if you go about this in the right way you will find it simple.

Get a narrow strip of brass or iron about ⅛-inch thick with a perfectly straight edge and bend the two ends at right angles so the inside distance from end to end is 8 inches. Place this on the Bakelite block (as shown in Figure 1) and clamp the block and the metal strip between the jaws of a vise with the edge of the metal strip along one of the pencil lines or scratches. Then, using this as a guide, cut a slight notch ⅛-inch deep with a hack-saw that has a tooth clearance of 1/32-inch. Loosen the block and strip, move the latter to the next double line and cut another groove. Continue until the entire eleven notches or grooves are cut, when the block should appear as in Figures 2 and 3. If, however, you have no large vise in which to clamp the block in this way, you may secure the Bakelite or fibre to a bench; by using a little care you will be able to make the grooves easily.

When the grooves are done, measure off 4 inches on the 8-inch side of the block and saw the block into two equal portions across the grooves. Then mark off a line ½ an inch from the edge of the 3 by 5-inch piece of wood or fibre and draw a line parallel with the 3-inch edge. Take the two halves of the grooved block, place them face to face, (adjusting them so that the grooves are absolutely in line, as in Figure 4), place them with one edge on the line along the other block as shown and clamp the three firmly in a vise. Then, with your ⅛-inch drill make four holes through all three blocks,

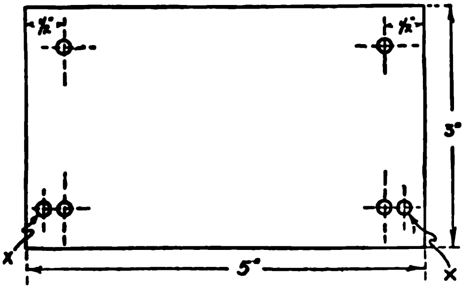


FIG. 4A

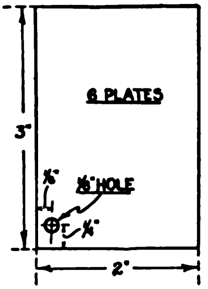


FIG. 5

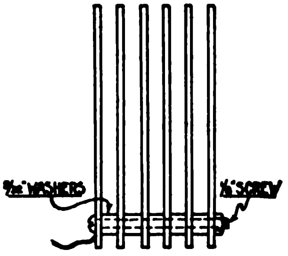


FIG. 5A

drilling about ¼ of an inch from the outer corners of the grooved blocks, and drill two more holes through the two projecting corners of the larger block, as in Figure 4 A (XX).

Next, mark off eleven rectangles on the sheet aluminum having each rectangle 2 inches by 3 inches in size. If you have trouble cutting the metal take it to a tinsmith and let him cut the pieces for you, as they must be true, square and all of exactly the same size. Then, clamp six of these together in a vise and bore a ⅛-inch hole through one of the corners, ⅛-inch from one edge and ¼-inch from the other, as shown in Figure 5.

Then clamp the other five plates together and bore two holes at the corners as shown in Figure 6, keeping the holes ¼-inch from each edge. Lay these last aside for the present and slip one of the 1¼ or 1½-inch bolts through the hole in one of the plates with the single hole. Slip a 5/32-inch washer, (or a ¼ and a 1/32-inch washer, according to which you use), over the bolt, put on another plate, then another washer until all the plates are on the bolt and are separated by washers as shown in Figure 5 A.

Twist a short length of wire around the screw under the head, and thread a nut loosely on the opposite end, then place the plates upright on a level surface so that all are in line and tighten on the nut with your fingers until the plates and washers bind and are fairly firm.

Now place these plates connected by the bolt in the grooves on one of the pieces of Bakelite with the end where the screw comes flush with one end of the block and with the screw head and wire at the lower corner. Then place the other piece of grooved Bakelite on the plates; be careful to adjust them until they fit in the grooves. Then slip the four long ⅛-inch bolts through the holes in the four corners of the blocks and screw the nuts on firmly, thus clamping the plates in the grooves. In doing this however, do not use so much pressure that the plates will buckle under the strain but screw down the nuts little at a time, first on one and then another, until the plates are firmly secured. When this is done, tighten up on the nut of the bolt which holds the plates together, place a binding screw in the hole in the corner of the larger block, connect the wire from the plates to this and the whole should then appear as in Figure 7.

Now take the strip of brass ½-inch wide and 2 inches long and bend the ends at right angles so as to leave exactly ¾ of an inch between the ends inside of Figure 8. Bore a ⅛-inch hole through each of these ends and another ⅛-inch hole through the brass strip in its centre. In this last hole, secure a short brass rod or brass bolt. If a bolt is used it may be fastened by means of two nuts as shown in Figure 8, or it may be soldered as preferred. On the other end of this rod place an insulating knob of some sort.

Now take the five remaining aluminum plates and place them on bolts exactly as you did the first six, slipping

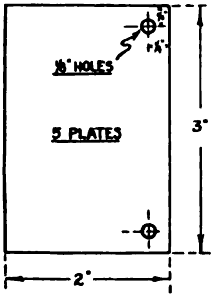


FIG. 6

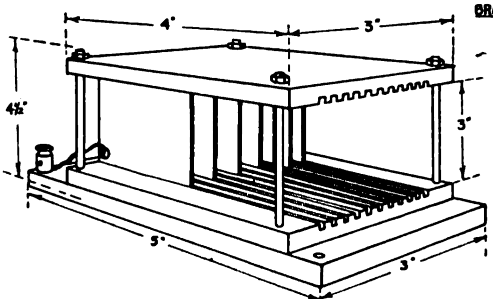


FIG. 7

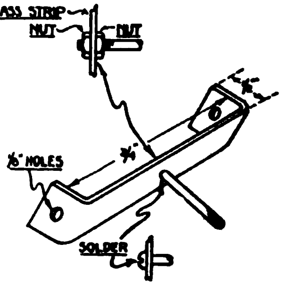


FIG. 8

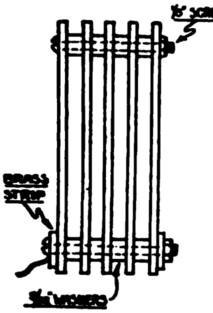


FIG. 9

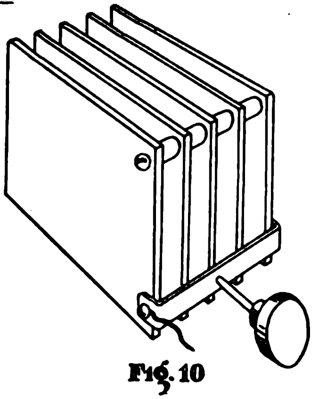


FIG. 10

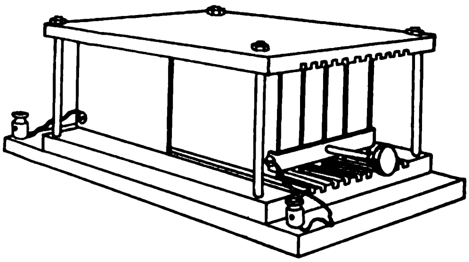


FIG. 11

a plate, then a washer and then a plate on the bolts, as in Figure 9. Place one bolt first; before screwing on a nut place the other bolt. This should be passed through one end of the brass strip bearing the knob, then through the plates and washers and finally through the other end of the strip, as shown in Figure 10. Finally twist a piece of flexible wire around the bolt under the head and tighten the nuts firmly.

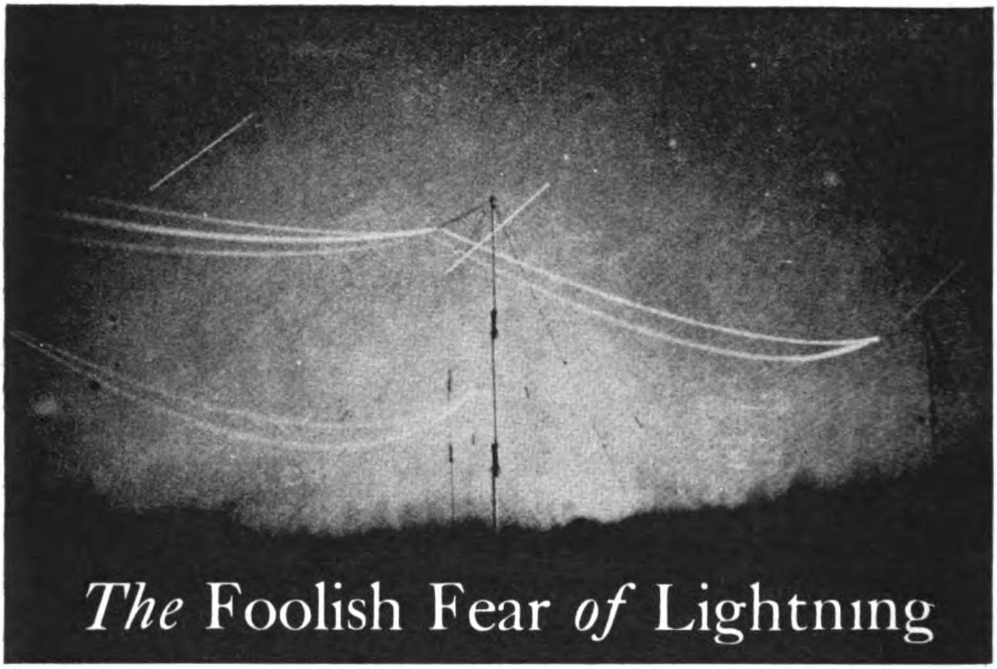
Now, if you have done your work accurately, it is only necessary to slide the five plates into the grooves between the first six, connect the flexible wire from the sliding plates to a second binding post and your condenser should look as in Figure 11, and be ready to connect with your set. Test it first to be sure it is not short circuited.

If you find that the sliding plates bind in the grooves, you may loosen the nuts on the long bolts that hold the blocks together and place thin cardboard washers under them until the plates slide readily. If the trouble lies in the spacing of the plates or grooves you may readily adjust the plates by placing very thin brass or copper washers or shims between the plates if they are too near together or by filing down the 5/32-inch washers if the plates are too far apart. Even if your grooves are unequally spaced you will have no difficulty in adjusting the plates to fit them, for by filing off the washers in one place and adding shims in another you can make the plates farther apart or nearer together at will.

Although this eleven-plate condenser will have ample capacity for the average set, you may at times require a large one. By merely adding to the size or number of plates and making the necessary alterations in the dimensions of the other parts you can build a variable condenser of any desired size or capacity.

IS RADIO RE-MAKING CIVILIZATION?

GEORGE CREEL, *the world-famous publicist and writer, thinks that it is—and says so with characteristic emphasis in the September issue of* POPULAR RADIO. *"When the citizens of one country learn at first hand by radio what the citizens of another country are doing and thinking," he says, "politicians will have a sad time attempting to play on ignorances and outworn hates. Real news is about the best binder the human family has ever developed. We proved it during the war—and we proved it by radio." And then he reveals an unwritten chapter of American history in which radio played a stirring and a vital part.*



The Foolish Fear *of* Lightning

Brown Bros.

If your antenna wires are not grounded, they may become loaded with static electricity and cause a "corona discharge" during a thunder storm. This phenomenon may appear terrifying—but it is entirely harmless.

By EDGAR H. FELIX

NEW inventions bring new fears. The bill to license construction of the first railway into London was vigorously and vociferously opposed in Parliament and by the press because the people feared the vibration of trains within the city would shake down every building in London within two years.

New Yorkers feared that the first voyagers on Fulton's steamboat would go to the bottom of the river instead of riding on its surface.

A Boston physician who tried to introduce anæsthetics into the operating room was mobbed because the people feared such use would affect the soul.

The world changes but little in its fears. A new invention today awakens fears similar to those of the past. Radio salesmen say people fear that lightning will be attracted to their homes if they install broadcast receivers; and it has been predicted by one ridiculous "prophet" that, as greatly increased numbers of antennae are put up for use, lightning will destroy a good part of our cities."

During a thunderstorm recently I inquired for the manager of a large down town New York City store who had just installed a radio department.

I was not, however, immediately allowed to talk with him, for he was excitedly giving instructions to have the lightning switch for the indoor antenna put in the grounded position. His words were repeated by his secretary: "He says make it snappy or lightning may strike the store any minute and set it on fire."

If lightning were thus attracted, the brass railings for the offices, the typewriters and every other metal object in the department store should be hurriedly dumped out into the streets with the first indication of every thunderstorm. The people in that store were in no more danger from the remote possibility of lightning being attracted by that indoor antenna on the lower floor of the steel building than they were in danger of the possibility of an army of African jungle gorillas walking in upon them at that moment.

When an intelligent and otherwise well informed radio department manager worries about lightning in such a case under such conditions, what may not be the worry of men and women in the homes where new broadcast receiving sets have been installed?

If this should spread, the telephone companies might find a new high peak of traffic just before thunderstorms due to broadcast enthusiasts telephoning home to make sure the lightning switch is in the grounded position. This is a thoughtful precaution but it offers little protection against a lightning discharge. If the conditions were such that lightning would strike anywhere near that home, it would strike there—antenna or no antenna.

Lightning, like other dangers we face, appears worse than it is. Of course, the probability of danger has been well advertised from the standpoint of public safety by the Board of Underwriters and from the business standpoint by manufacturers of lightning arresters.

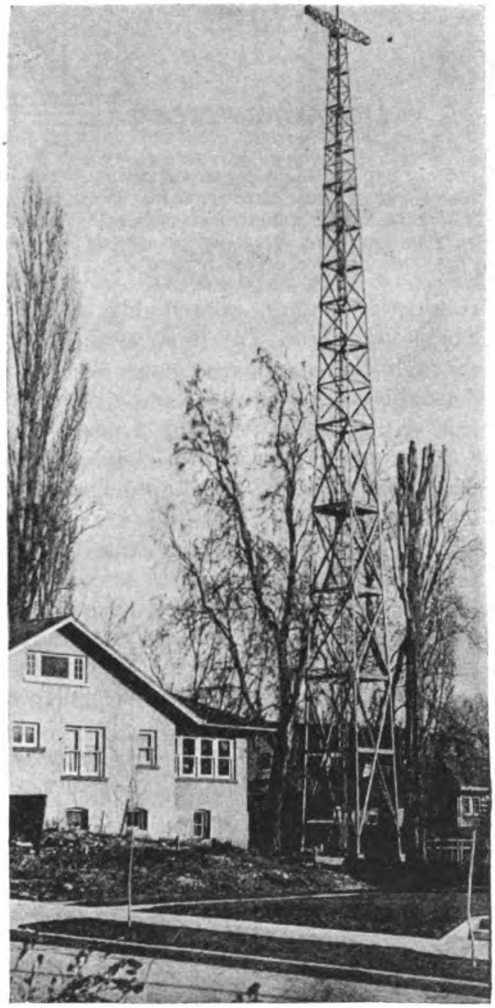
Fears disappear with knowledge of the facts. The facts that relate to the possibility of lightning striking an antenna are of two groups: facts of experience and facts of science.

As to facts of experience:

After twenty years of radio, there are but few cases on record of antennæ being struck by lightning. It is nonsense to attribute to a radio antenna the power to attract or change the course of a lightning discharge of billions of volts and millions of amperes.

Here are a few of the facts of science:

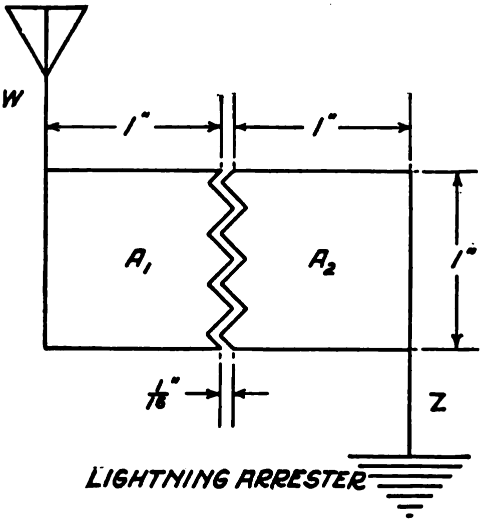
Most visible lightning discharges take place between clouds of different potentials. If every flash seen during a storm were grounded to earth in the form of a direct discharge, a thunderstorm would invariably be accompanied by tremendous damage, but instead of this, most of the charges gathered on clouds are dissipated through a continuous stream of leakage between the earth and the clouds. Nature with her usual foresight, always accompanies high humidity and heavy rain with a highly charged cloud atmosphere. In this way she punctures the insulation of air between the clouds and the earth by a continuous stream of minute



Keystone View Co.

YOUR ANTENNA PROTECTS YOUR HOUSE

It no more attracts lightning than does a tree; if a bolt does by chance hit the antenna, it acts as a lightning rod.



An air gap lightning protector can be made of two pieces of brass plate shaped as shown above. These should be mounted on a suitable insulated base and the receiving set should be connected across W and Z.

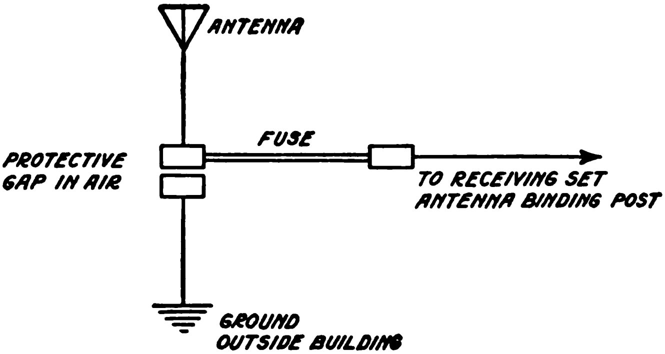
conducting bodies, each highly charged. Some of these continually discharge through the antenna system, as is evidenced by that unpleasant noise which we call static. Thus, there is a continuous conducting path between a cloud and the earth, resulting in a lightning flash only when extremely high charges are present. When such a discharge takes place, a current of millions of amperes and billions of volts drain the cloud of its charge.

A thunderstorm, then, clears away the charges on the clouds in two ways; first by a continuous stream of charged raindrops and conducting ions; and second, by direct discharges, such as take place between the electrodes of a spark gap. The latter is usually preceded by a collection of charges from nearby clouds until sufficient potential has been collected by some one cloud to break its way directly to the earth through a space of from one and a half to two or more miles.

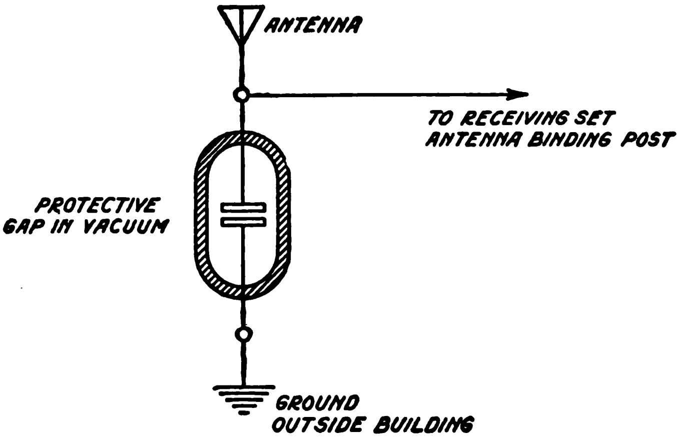
An electric charge sufficiently strong to break through a space of that distance is of such intensity that its course is influenced very slightly by the relatively small attraction of a piece of antenna wire. Moreover, a grounded antenna is at the same potential as the earth itself.

Since the potential of the antenna is practically the same, the only other assumption that might make it seem that an antenna might be an attraction for a lightning discharge is the fact that the antenna is nearer the cloud than the surface of the earth. The cloud is from 7,000 to 11,000 feet away. The ordinary receiving antenna for broadcasting is seldom more than a hundred feet in the air. A hundred feet more or less travel for a charge of billions of volts is not sufficient to make such a charge change its course as much as twenty feet in order to find such a little path of less resistance. In the few cases known of lightning striking an antenna, it is certain that it would have struck at that very spot if no antenna had been there.

The actual ionized path established by



This lightning protector has a fuse leading in to the instruments. If lightning should strike, the long fuse would blow out and the electrical discharge would take place through the gap.



A VACUUM TYPE OF LIGHTNING ARRESTER

The instruments are connected to the antenna and ground as usual, with the gap shunting the windings. Any electrical surges that gather on the antenna immediately cause a discharge across the gap in the vacuum.

a direct cloud discharge is at the most but a few inches in diameter. Surrounding this ionized path of direct discharge, there is a large accompanying discharge, perhaps several miles in area. This entire area is influenced by the terrific current grounded by the lightning discharge. Sensitive receiving sets are greatly affected by this for several miles around—perhaps anywhere within a radius of scores of miles. It is against this sympathetic discharge that we take our main precautions.

The lightning arrester dissipates such charges with certainty and safety even though the antenna is not grounded, and so forms actual protection, similar to that of the time-honored lightning rod.

The lightning arrester is a safety gap designed with such electrodes that a charge on the antenna of over 500 volts is grounded with the greatest possible facility. Whenever a charge of sufficient voltage is collected on the antenna, a spark discharge takes place across the toot-like electrodes of the arrester gap.

Against an actual discharge—that is, lightning striking at a particular place—there is no real protection possible.

Since the actual ionized path of such a direct cloud discharge is but a few inches in diameter the owner of a broadcast receiving set should not expect his particular little antenna with no especial attracting features to be picked out. He would be as much an egotist as an old maid in her little back yard holding out an up-turned thimble, confidently expecting that when but one rain-drop falls from a cloud two miles away, it will so distinguish her as to direct its way to her thimble when it might as easilly fall anywhere else within the State.

In planning lightning protection, make certain that your antenna is protected by a grounding device as required by the Board of Underwriters. This protects you against damage occasioned by any discharge taking place through the antenna either because of natural leakage or because of indirect cloud discharges and lightning discharges nearby. By having the grounding device properly installed the insurance on the property is protected. A radio set that is properly set up with antenna and with ground connections made in the correct way, affords better protection against lightning than if it were not installed. There is absolutely no justification for the hysterical fear that a radio installation will "draw" lightning—no more justification than in the case of the child's fear that some grinning hobgoblin will jump out from the dark.

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department; it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: Please tell me if two receiving sets can be used on the same antenna. I have an antenna 170 feet long, stretched between two trees. One tree is in my neighbor's yard and he would like to listen in also. Would it be better to place a breaker in the centre of the antenna so that my neighbor could use one-half 85 feet long and I the other half?

W. W. BLAUVELT

ANSWER: The second method would be the better. Place an insulator at the center of the 170-foot antenna wire, thus splitting it up into two antennae of 85 feet each.

QUESTION: On page 59 of the May issue of POPULAR RADIO is a diagram of a honeycomb set for receiving high-powered undamped stations. Can this set be made to receive concerts on 360 meters? What size honeycomb coils should be used?

J. J. MILLER

ANSWER: This set may be used for broadcast reception. The coils should be: Primary L-35, Secondary L-50 and Tickler L-75. A crystal detector can be used for concert reception, but the results will not be as good as with a vacuum tube, as the crystal detector is not as efficient a rectifier as the vacuum tube.

* * *

QUESTION: I am interested in the hookup of a set I saw in your department; you mentioned that it was capable of receiving foreign high-powered stations. Does this mean telegraph signals or concerts within this range? Would the set shown on page 60 of your May number receive concerts?

B. BOUCHIER

ANSWER: The first set will receive undamped telegraph stations within the range mentioned. The set described on page 60 is meant for short wavelength reception and is capable of receiving concerts over a range of 300 miles, if conditions are favorable.

* * *

QUESTION: I have an induction coil, about 6 inches long and 2 inches in diameter. Can I hear anything on it if I use it for the tuner in a radio receiver? If so how will I connect it?

JOS. I. BROWN

ANSWER: If you mean a tuning coil of the above dimensions, it ought to be suitable for use as a single slide tuner. A circuit for this type of coil was published in the July issue of this magazine.

* * *

QUESTION: I have a toy transformer such as is used for operating toy electric trains. Could it be used for lighting the filaments of a vacuum tube, or for the "B" battery voltage? It operates on 110 volts alternating current, and any voltage from 1½ to 29 volts may be obtained from it by attaching the wires to different binding posts.

H. H. SMITH, JR.

ANSWER: This transformer will not give you satisfactory results, as the current it supplies is alternating. As a radio receiving set is primarily a detector of alternations or oscillations, there would be heard in the telephones a continuous buzzing sound that would drown out the signals you wish to hear.

* * *

QUESTION: I have a variometer, a loose coupled tuning coil, two variable condensers, a fixed condenser, a mineral detector, and a pair of 3000-ohm telephone receivers. What is the best circuit with these instruments?

E. S. C.

ANSWER: A circuit is shown in Figure 1 which will be suitable for you to use. The variometer is not needed in the circuit with a crystal detector, however.

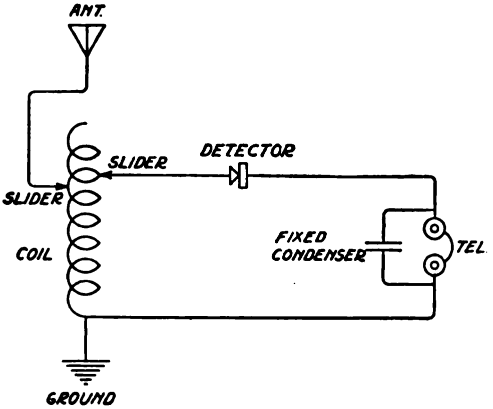


FIGURE 2
Circuit for use with a crystal detector, in which a two slide tuning coil is used for coupling the antenna and secondary circuits.

QUESTION: Can a variometer or a variocoupler be used separately for tuning? If so, please give me a hookup for use with a vacuum tube.

C. B. POWELL

ANSWER: Either of these instruments may be used for tuning. The variometer, however, must have the rotor disconnected from the stator. A hookup for using either of these instruments with a vacuum tube as you desire, was published on page 223 of the July issue of POPULAR RADIO.

* * *

QUESTION: I would like to know if insulated wire can be used for an aerial.

HARVEY C. NEWELL

ANSWER: Yes. Either bare or insulated wire may be used.

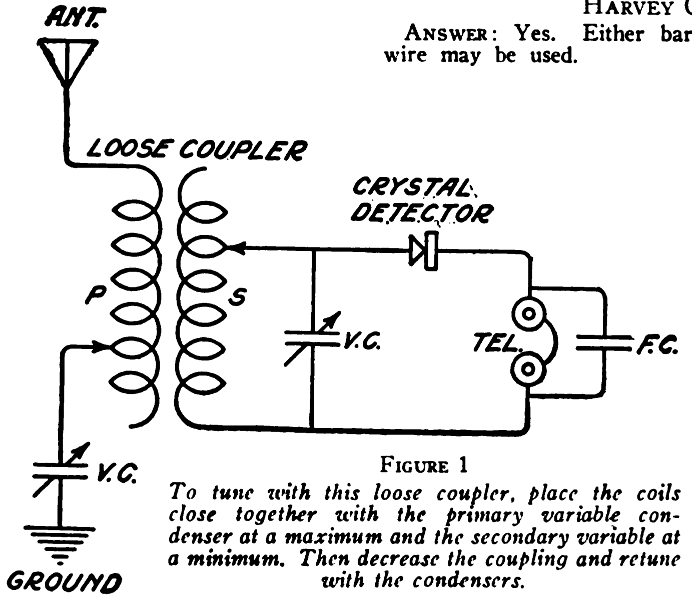


FIGURE 1
To tune with this loose coupler, place the coils close together with the primary variable condenser at a maximum and the secondary variable at a minimum. Then decrease the coupling and retune with the condensers.

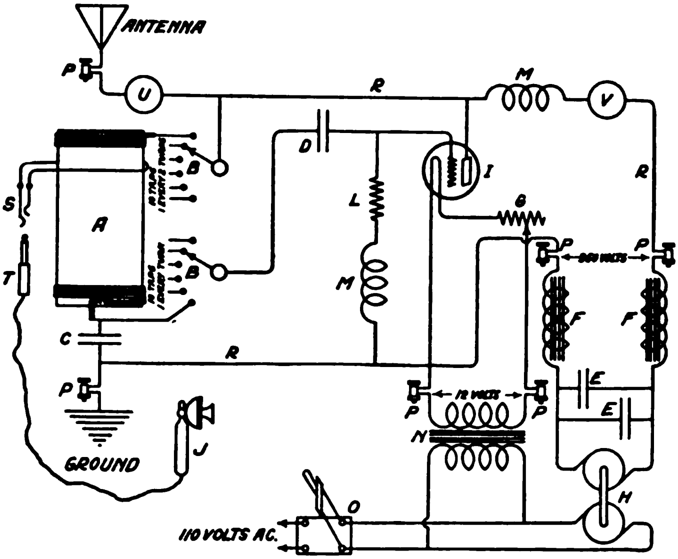


FIGURE 3
This whole set may be operated with the ordinary alternating house current of 110 *volts.*

QUESTION: I have a good receiving set and want to make a small radio telephone sending set. I built my receiver myself; now I want to construct a sender. How can I construct a simple set that will work well and still be easy for me to make with a few tools?

A. THOMAS

ANSWER: First of all, for your proposed set you should obtain the following materials:

A.—One length of Formica tubing, 6 inches long and 4 inches in diameter.
  30 feet of No. 14 bare copper wire.
B.—20 switch points.
  2 switch levers and knobs.
C.—1 .001 mfd. mica condenser.
D.—1 .0003 mfd. mica condenser.
E.—2 1. mfd. paper condensers.
F.—2 1½ henry choke coils.
G.—1 power rheostat.
H.—1 350-volt motor-generator.
I.—1 radiotron UV-202 vacuum tube.
J.—1 Federal hand microphone.
L.—1 5000 ohm grid leak resistance.
M.—2 L-100 honeycomb coils.
N.—1 toy step-down transformer 110 volts to 12 volts.
O.—1 D. P. D. T. switch.
P.—6 binding posts.
Q.—1 piece of dry pine board, for mounting the instruments.
R.—15 feet of No. 14 wire for connections.
S.—1 telephone jack.
T.—1 telephone plug.
U.—1 hot wire ammeter, 0-1 amp. scale.
V.—1 D. C. milliammeter, 0-100 milliamp. scale.

The materials listed under the heading A are used to make up the inductance. Wind the thirty feet of wire on the tube, beginning at one end of the tube, and at the same time wind on with the wire a piece of cord 1/16 inch thick, to keep the wires from touching each other on the adjacent turns. Solder taps to the coil as shown in the diagram and fasten to the switch points of the switches B.

The rest of the instruments and materials specified should be connected as shown in Figure 3. If the diagram's instructions are followed explicitly and the set is connected to the proper antenna, the set will work efficiently as soon as the switch O is closed. The transmitting wavelength is adjusted by turning the switch B. The lower switch B is used to get the maximum antenna current as indicated by the meter U. The plate current is shown by the milliammeter V. Using one vacuum tube the normal plate current should be kept down to 50 milliamperes. If you should wish at some future time to use more than one tube, it should be connected in parallel with the existing tube. This will increase your transmitting range.

* * *

QUESTION: Please tell me which is the tuning device—a variocoupler or a variometer—for a crystal receiving set? Which is better and how far will it receive with 2000 ohm receivers?

A. S.

ANSWER: Both the variometer and the variocoupler are tuning devices. The variometer is a single circuit inductance which is variable, and the variocoupler is a two circuit inductance, the secondary winding of which is of a fixed value and the primary winding is variable by taps. We cannot answer questions as to distances a set will receive.

* * *

Question: Would I increase the range of the set described in the June issue of Popular Radio if I put in a loose-coupler or a variocoupler in the hookup instead of the coil? Floyd Gibson

Answer: This would increase the selectivity or tuning ability of the set considerably, and the distance range slightly.

* * *

Question: Please send me a diagram of a set for receiving broadcasting that does not use a crystal detector.

Curzon Ferris

Answer: We are publishing on this page a diagram of a simple tuning coil that is connected up with a vacuum tube detector. We believe this will be simple enough for you to construct. See Figure 4.

* * *

Question: Is there any way to fix a tinfoil shield to a wooden panel for a regenerative circuit? Edw. H. Bucher

Answer: You may accomplish this by using shellac as a glue to be applied to the tinfoil. The tinfoil should then be pressed on the back of the panel and smoothed out. The tinfoil should be cut away where the instrument binding posts touch or pass through the panel. The ground binding post, however, should be connected to the shield.

Question: Will I be able to receive music from a good broadcasting station, within a five-mile radius, with the crystal set described in the May issue of Popular Radio? Could I hear music from that distance with a single wire aerial about 30 feet high?

L. P. Clark

Answer: You should be able to hear the music satisfactorily with the set mentioned with the single wire antenna at this distance.

* * *

Question: How far under favorable conditions, would you be able to hear with a set as described by A. Hyatt Verrill in the June issue of Popular Radio? What is the cost of a good variocoupler? What is the function of the variometer, and what is the cost of a good one?

G. G.

Answer: The set described should work reliably over a distance of 50 to 75 miles. The variometer is a continuously variable inductance and is used for tuning a circuit to resonance. A good variometer or variocoupler can be obtained at a price between $7.00 and $10.00.

* * *

Question: I am interested in radio and wish to qualify as an operator. Will you please acquaint me with some Correspondence School that will furnish me with this training?

P. Christensen

Answer: There are several good schools of this kind; the one nearest to you is the National Radio Institute, Washington, D. C.

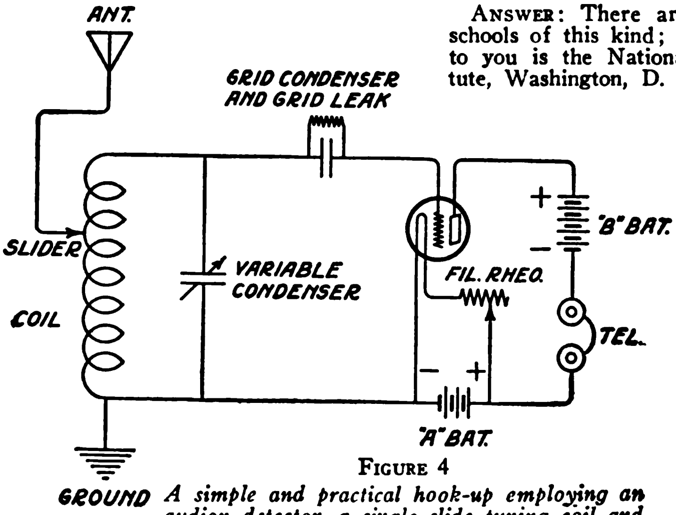


Figure 4

A simple and practical hook-up employing an audion detector, a single slide tuning coil and variable condenser.

ITEMS *of general interest that you ought to know; bits of information of practical usefulness to every radio amateur.*

More Short Wave Bands For Broadcasting

MORE short wave bands for broadcasting, nominal fees for licenses, and provision for permits before erection of transmitting stations are among the changes incorporated in a bill just passed by Congress. All that is needed now to put these changes into effect is the approval of the Senate.

More liberal provisions for broadcasting on short wavelengths are provided in the bill which gives broadcasting by the Federal and state governments and public institutions exclusive rights to the wavelengths from 485 to 495 meters. This is essentially the same wave used for government weather, crop and market reports now. Those who live away from the seacoast will have a larger variety of radio waves to utilize under the recommendations. The band from 285 to 485 meters is assigned to private and toll broadcasting, but the zones from 285 to 315 and from 425 to 475 meters will not be used in regions near the coast because of the chance of interference with marine radio communication. For similar reasons the experts have limited government and public broadcasting on 650 to 700 meters to 400 or more miles from the seacoast, and similar broadcasting on 700 to 750 meters must not be done nearer to the coast than 200 miles.

By the establishment of a new band of wavelengths from 100 to 150 meters for the exclusive use of private and toll broadcasting, the experts foresee the establishment of short range broadcasting. It is expected that this will be a development of the future; that due to the fact that few radio receiving sets as they are now made can receive radio waves shorter in length than 200 meters, it will be possible to establish radio entertainment service on the basis of renting receiving sets adjusted to a particular wavelength. The use of shorter wavelengths will introduce new problems into radio apparatus manufacturing and will also allow the establishment of a large number of low-power, short wavelength transmitting stations in a small area. Each city will be able to have its own transmitting station of this character and will operate without interfering with other stations.

Reasonable fees that will help to pay the increased cost of radio regulation are proposed in the bill. It also provides for permits before a transmitting station is erected rather than after it is erected and before it begins to operate as is now the case.

The Best Home-Made Amateur Station in America

IN a small town in New Mexico, isolated from the active radio world by broad deserts and high mountains, an amateur has built a wireless station which has been awarded the Herbert Hoover cup for 1921 for being quite the best product of amateur skill.

Louis Falconi, known as 5ZA to amateurs who have heard him in every part of the country, was chosen by the American Radio Relay League because of the ingenuity he displayed in making a large part for his apparatus, electrical efficiency of the set, transmitting range, receiving performance, observance of radio law, ability of the operator to handle messages, amount of traffic handled and completeness of the station log. For several years his station has been the chief connecting link between the Mississippi Valley and the western coast, and he has been heard in every state but Maine. He communicates with ships both on the Atlantic and the Pacific Oceans and is consistently heard as far away as in the Hawaiian Islands.

The difficulty in getting proper radio supplies was the mother necessity which made Falconi the inventor of many parts used in his set which now not only includes a spark transmitter but a continuous wave transmitter, I. C. W. telegraph and radiophone. The phone has been heard as far east as Indiana and in many other distant states.

It was Falconi's station which connected Chicago with Los Angeles last summer when a message was relayed from Hartford, Conn., to Los Angeles, Calif., and a reply returned to Hartford in six and a half minutes.

Radio Helps Aviators in Making Landings

A NEW method of helping airplanes to locate the landing field and come to earth safely with the use of radio has been developed by the Bureau of Standards after several years of study. Radio direction finders and other devices have been in use for a long time to assist airplanes in landing during the night, in the fog, or at other periods of poor visibility. The usual method of using radio for this purpose is to transmit from any ordinary elevated antenna at the landing field radio signals which are received on a direction finder carried by the airplane. This

Fotograms

THE WORLD'S BEST CODE OPERATOR

When Theodore McElroy took down code messages at the rate of 56½ words a minute with but one error at a recent radio show in New York, he won the title of "champion radio code operator of the world," and was given a silver cup as evidence of his skill.

method gives the direction of the landing field, but it does not tell accurately the distance from the plane to the field.

The aviation experts of the army and navy have long wanted a method that will give a signal heard over a comparatively large area when the airplane is at a high altitude but which is localized within a small area when the plane is near the ground. A large horizontal coil tuned to 500 cycles was tried by the Bureau of Standards but did not prove satisfactory. Experiments were then made with radio frequency waves, and two horizontal coils, one above the other and with current flowing in opposite directions, were used. A fairly high radio frequency, such as 300 kilo-cycles or a wavelength of 1,000 meters, was used in this case. The signals that radiated from the two coils were the strongest for an airplane flying in a given horizontal plane whenever the airplane was within a comparatively small ring-shaped area located above the landing field.

Kadel & Herbert

ONE MORE "SMALLEST" TUBE SET

This "peanut tube" receiving apparatus, which is said to have a range of 75 miles, weighs less than 1½ pounds. It won first prize for its young maker, Sterling G. Sears, at a New York radio show, where it was adjudged the most suitable small set yet devised for use by the police.

Radio Beacons Send Out Warnings at Sea

SO successful have proven the five radio beacons with which the Department of Commerce has been experimenting for sending out warning signals to ships in fog and heavy weather, that five more stations have been authorized. The new beacons will be installed at Boston, Nantucket, Cape Charles, Columbia River and Puget Sound.

Foreign ships are being equipped with direction finders to enable them to tell the direction of the warning beacons, and foreign authorities are watching America lead the world in this new development of the science of navigation.

At present the five stations which stand watch on our coast are located at Ambrose, Fire Island and Sea Girt near New York and on the light ships off Cape Hatteras and San Francisco. The radio signals are sent by automatic devices which operate at regular and frequent intervals.

Will Trains Be Controlled By Radio?

WILL the next step in "safety first" railroading be routine radio communication between train and dispatchers? This is the question that is being asked by those who see the future significance of the Interstate Commerce Commission's final orders to forty-nine railroads to establish automatic train control devices on their lines before January 1, 1925.

The first trains ran "wild" with no other control than that of the engineman. When two trains used the same track in opposite directions, the first control was

U. S. Signal Corps

THE FIRST USE OF RADIO IN A BALLOON RACE

Radio in free ballooning was used for the first time in the national balloon race which was won by Major Oscar Westover, who covered a distance of 850 miles—300 miles farther than any of the other contestants. Major Westover used fifteen feet of copper wire screening like that ordinarily used for windows, for lining the balloon basket and to form the ground; the aerial—a single strand over a hundred feet long—was dropped from the side of the basket. With a two-stage receiving set of the common commercial type stations were heard a thousand miles away. Code messages were received successfully, and weather reports reached the balloon regularly at noon and midnight.

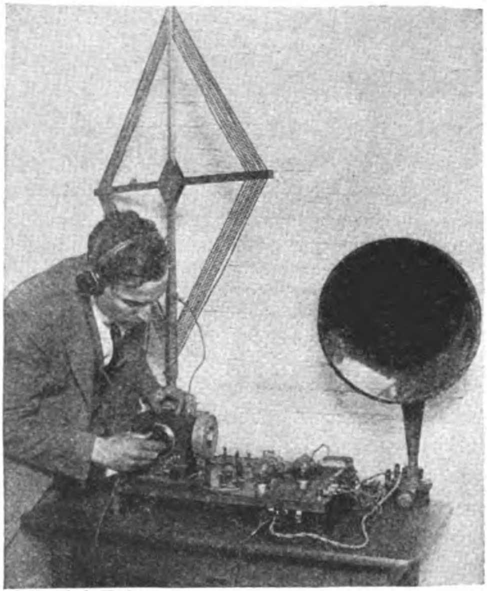
through synchronized watches. Watch failure or an engineer's impatience often resulted in a head-on collision. Then came the telegraph and the red light and its resulting intermittent communication between dispatcher and engineer. As the air brake was perfected and speeds and weights were increased, the block signal system, and later the automatic interlocking signal system came into use, extending the intercommunication between dispatcher and train. Now comes the automatic train control to insure that engineers will do with their trains what the signals indicate they must do. Yet with the best of signal systems and the most reliable of automatic control the fact remains that a fallible human being is propelling an engine at tremendous speed with only intermittent communication with those who might warn him of danger or tell him why he should stop.

The use of radio would keep engineers and conductors in continuous touch with all stations on the right of way. Its installation by legal enactment is believed by many to be as inevitable as was that of the air brake, the block signal and now the automatic train control. Its coming seems to be only a matter of time.

Spreading the Gospel By Radio

CHURCH authorities have been quick to seize upon the radio as a medium for spreading Christian propaganda; presumably it is only a matter of a short time when the Jewish, Buddhist and other faiths will follow suit. The broadcasting of church services has already become a more-or-less fixed institution and no longer has elements of novelty except in its special applications; one of these comes from a church in Syracuse, whose pastor has just announced that all the shut-in members of his congregation will be furnished with receiving sets at the church's expense, to enable his parishioners to listen-in on his weekly sermons that are broadcasted from station 8BNY. Still more recently comes the announcement that the station WJZ at Newark has undertaken to broadcast the Bible at the behest of the American Bible Society. Thousands will hear this new program.

Will the warfare between the various religious sects that have marked the history of the world be now lifted into the ether? Will the government authorities eventually have to step in to regulate proselyting?



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AN AMAZING FEAT OF A RECEIVING SET

A remarkable demonstration of the impending development of receiving apparatus was recently given in New York by Edward H. Armstrong, the distinguished scientist. With a small loop antenna, his set gave results comparable with that of the common type of set connected to an outside antenna. Wonderful results were obtained with no antenna at all, and the interference from other stations and from static was practically eliminated. An extraordinary feature of the "super-regenerative circuit," as it is called, was the use of only three vacuum tubes, which gave the same amplification as the ordinary receiving set with nine tubes. In the course of his demonstration Mr. Armstrong filled the large auditorium with music from WJZ at Newark.

Radio Weather Signals Are Dimming the "Weather Eye"

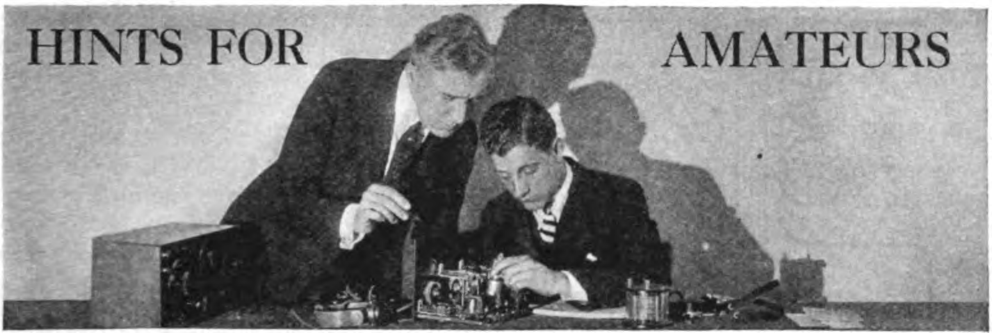
ANOTHER charge may now be lodged against radio by the old-school romanticists—it is undermining the authority of the sea captains by taking away from them their traditional jobs of forecasting the weather.

The new order of things has just been inaugurated along the Pacific Coast, where definite and scientifically accurate data on weather conditions is broadcasted from Alaska to Mexico for the special benefit of mariners.

To the radio compass bearing service, established a year ago for the purpose of giving masters of vessels accurate compass bearings by radio, has been assigned the task of broadcasting the weather "dope" twice a day. The reports, originating in San Francisco at the Bureau of the Weather Department and sent out from the radio station at that point, are picked up and relayed by more than a score of other stations. The first report went out on a wavelength of 4659 meters; it was picked up at the naval radio station at the Los Angeles Submarine Base and was relayed to Alaska, British Columbia and Canadian points, Washington and Oregon; Honolulu also picked up the reports and broadcasted them to vessels within range of the Hawaiian station. A regular schedule has now been worked out; the morning bulletin is to be served daily at noon (75th meridian time) at a wavelength of 4650 meters C. W. The evening bulletin will be flashed at ten thirty at a wavelength of 1908 meters D. R.

The bulletins are divided into two parts and invariably begin with the letters USWB. The first part consists of surface weather conditions based upon observations taken at 8 A. M. and 8 P. M.; and of upper air observations taken in the afternoon of the date of distribution. The second part of the bulletins consists of synopses of general atmospheric pressure distribution.

HINTS FOR AMATEURS



THERE are numerous ways of installing the antenna in the summer time when one is away in the country, but the method that first suggests itself, in case there is no tall building to hitch it to, is to fasten the antenna between two tall trees.

This is a good idea, even if many of us have tried it out with results that were not altogether satisfactory. That is because the tree in the summer has its veins filled with sap. The tree in this condition is in itself a veritable antenna.

If we install our receiving antenna close up to the branches of the tree, the tree will absorb the energy that would ordinarily be induced in the antenna, and the antenna would get little or none of its rightful electrical energy, and we would hear weak signals or no signals at all.

Keep your antenna at least ten to twenty feet away from trees or branches of trees. This may be done by fastening one end of a rope or wire of ten or twenty feet in length to the tree, and fastening the insulator on the other end of the rope. Then fasten the antenna wire to the insulator. Do the same thing on the other end of the antenna, and you have your antenna supported efficiently between the two trees without being close enough to the trees to sustain losses by absorption.

* * *

HONEYCOMB coils absorb moisture in damp weather, and this causes leakage. The coils may be dried out and made moisture-proof by immersion in melted paraffine until all bubbling has ceased. If the coil is of the unmounted type the ends of the coil should be tied fast with a string, as the sealing wax that they are fastened with will melt in the paraffine and the coils will unwind unless the ends are tied.

* * *

KEEP your storage battery filled with distilled water so that the plates are always covered, and your battery will retain its charge longer and its life will be considerably lengthened. Do not add acid to your battery, as only the water evaporates.

* * *

WHEN you connect batteries to other radio instruments, you may avoid trouble if you take the following precautions: connect the wires first to the instruments in the proper way, and then when you are sure that everything is correct, connect one of the free ends of the wires to the correct terminal of the battery. Then take the remaining wire and quickly touch it to the remaining terminal of the battery. If the bulbs do not light up or if they light up too brilliantly for an instant, you know there is something wrong, but there will be no harm done. If you connect the battery first, the two free ends might touch together and cause a short circuit.

The same rule applies when disconnecting a battery from apparatus; disconnect the battery first and then disconnect the wires from the apparatus. This may be more easily remembered in the form of a rule: Do all your connecting and disconnecting of apparatus with no voltage on the apparatus.

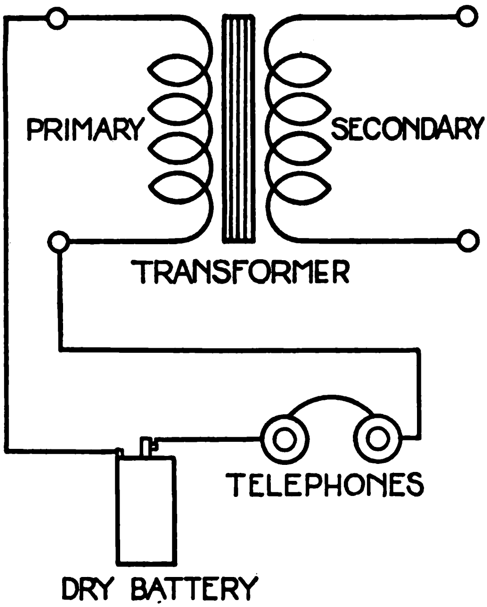


FIGURE 1

A circuit for testing an amplifying transformer for a burned-out winding. One of the wires leading to the windings is touched on the transformer terminal; if the winding is continuous a sharp click will be heard in the telephones.

A GRID leak may be made by cutting a piece of cardboard into a piece about one inch square, and covering it with a uniform layer of india ink. After it has dried, cut this piece in half and bore two holes in one of the pieces one half an inch apart. In these holes insert brass 6-32 machine screws, flat-headed, and fasten them tight with nuts on the other side. One screw will be one terminal and the other screw will be the other terminal of the grid leak, while the india ink will form the resistance. This resistance may be varied by cutting the strip narrower and narrower while listening after each cutting to see if the signals are getting weaker or stronger with the changes in resistance. A record may be kept of the different widths; then when the maximum results are recorded and further cutting begins to decrease the strength of signals, the second piece of cardboard may be cut to the correct size and the grid leak connected to the set for permanent use. The grid leak should be connected either across the grid condenser, or from the grid of the tube to the negative filament connection.

* * *

A GOOD way to test out an amplifying transformer to find out if it is open-circuited, is to connect one end of the winding to one terminal of the head telephones. Then, with the telephones on the ears, touch the other terminal to a dry cell which is connected to the other end of the winding of the transformer. If the transformer winding is all right a clicking noise will be heard in the telephones. Then try the same thing with the secondary winding of the transformer. If no clicks are heard, one of the windings of the transformer is "open." A circuit for making this test is shown in Figure 1.

* * *

THE sensitivity of an audion tube sometimes may be increased by placing a large horse-shoe magnet in a certain position so that the poles of the magnet are on each side of the tube. This probably is due to the magnetic effect upon the moving electrons that flow across from the filament to the plate. The amateur experimenter will find this a good field for him to investigate as he may hit upon some new idea along this line that will be an improvement upon the present-day vacuum tube. Needless to say, if this should be the case, his fortune would be made.

* * *

A DETECTOR tube will not work efficiently as an amplifier, as it will not stand as high a plate voltage as the amplifier tubes. Its only point of difference from the amplifier tube is that it has not been evacuated to such a high degree of vacuum; some gases are allowed to remain in the tube. It is this gas that will not allow the application of a higher plate voltage, as the gas ionizes, and makes the tube steadily conductive from the filament to the plate. A blue glow can be seen in the tube when this takes place. Use an amplifier tube for amplification.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to Editor,* ADVENTURE IN THE AIR DEPARTMENT, *9 East 40th Street, New York City.*

I Pick Up an Old Friend in Mid Ocean

WHY is it that such a large percentage of the "adventures" that reach the Editor come from operators who have been at sea? Perhaps because the call of the great waters is heard most keenly by those who are quickest to recognize an adventure when it comes their way.

All was quiet when I relieved the first operator at midnight. Only an occasional splash of static broke the stillness of the radio world on the Atlantic.

Shortly after one o'clock I heard a chap testing; apparently he was just putting in the time and listening to the noise of his own spark discharge.

For something to do, or maybe to assist in keeping awake in the course of my watch, I started up and called him, asking whither he was bound. He answered immediately and named a northern port. I had been there possibly half a hundred times and the name of that city called back many pleasant memories—for the girl lives there. It almost made me feel that the fellow was a friend of mine when he named his destination.

He was a beautiful sender and it was a pleasure to work with him. We became chummy in a radio way, and "o.m." (old man) occurred frequently in our exchange of commonplace words.

After we had talked a while, taking care to keep within regulation topics, he said; "Say o.m., your sending sounds familiar. What is your name?"

I told him, and I nearly fell out of the chair when he replied, "Well Holy Smoke! This is Henderson who sat behind you in High School and who left with you from our home town to get our first ships."

You can imagine my surprise at "meeting up" with a friend I had not seen nor heard of for three years. I had tried to locate him but I could get no trace of him.

Two weeks later I received a letter from him, and the old friendship was renewed.

CANADIAN OPERATOR

Romance by Radio

AFTER reading the following item that came from Canada, the Editor understood why the contributor preferred to remain anonymous:

About a year ago a local station was giving concerts by radio. One evening, after a couple of selections (one of which was a solo by a young woman), the operator asked for some one who was listening in to give a report on the articulation. I called him up by phone and did so, after which I asked permission to speak to the young artist. My request was granted. She was a very nice young woman, and I was soon chatting with her with animation. I made her promise to sing for me by radio. But I had overlooked possible consequences.

After one or two selections the operator came to the radiophone and called me several times; he announced that Miss Blank would like to speak to me. She came to the transmitter and said twice:

"Hello 3XX; I am going to sing a love song for you."

There were half a dozen people in my station at the time, and I sought desperately to turn out the filaments, but they would not let me. I was too confused to catch the song, but my visitors were having a rare time at my expense. As soon as the last words of the song died away several spark stations opened up with "Hi Hi" as a sort of grand finale. After the concert several stations called me and asked embarrassing questions.

The next morning when I went to the front door to pick up the morning paper, I found that some wag had written on the front of the house, in large characters, "3XX; I love you." The paper had an interesting account of the concert of the previous evening, and I read the cheering news that the program had been heard about 150 miles and by several thousand persons.

That cured me. The next time I do any flirting it will not be done by radio.

Anonymous

The Shortest Long Distance Record

NOW and then some stations are given up by their owners and the calls are assigned to others who may be many miles away from the previous users. A fan who hears a call may therefore be misled as to its whereabouts in looking it up in the call-book—as in the following case:

A station in Washington was recently assigned an old call which we will designate as 3AB; it had previously belonged to a station at Norfolk, Virginia. Near to it is another station, which we will call 3BTD, which had just started up. The following communication was heard the other night when these two stations got in touch with each other:

3BTD: "Yes, your signals are coming in very strong, old man. How are mine?"

3AB: "Yours are coming in strong. Have you a telephone?" (3AB wanted to tell 3BTD that he was out of hours for local work.)

3BTD: "No, I have no telephone. This is —— —— at —— Street, Washington, D. C. Are you 3AB of Norfolk, Va.? Your signals come in steady and strong here."

3AB: "No, I am in the city. See you later; good-bye!"

These stations were so close together that if the operators had poked their heads out of their windows they could have carried out their conversation by shouting!

C. A. Briggs

Radio Traps a Thief

SOMETIMES the wireless has been used in unexpected ways—ways to which the underworld has not yet adapted itself. For instance:

For several years a department store organization that has one store in New York and another in Philadelphia handled much of the traffic between the two stores by radio at a considerable saving in telegraph tolls.

One day I was calling on a friend at the office of the New York store. Word had just been sent up that a customer had charged to her account a valuable fur and wanted to leave the store with it at once. Because of the large amount involved, approval was desired by the salesman before the customer left the premises.

The credit man was consulted; at the same time a radiogram was filed to the Philadelphia credit department. The customer was kept waiting by various subterfuges on the part of the salesman. The true reason for the delay could not, of course, be given, for it might result in the loss of a valuable account.

The answer from Philadelphia came before the report from the credit office located on the same floor. A brief telephone conversation—and an indignant woman was ushered in, assisted by the strong arm of a detective. A messenger came in from the New York credit department and reported the account satisfactory. My friend smiled to me.

The woman had not counted on radio. The message revealed that the lady whose name was signed to the charge slip was at that moment in the Philadelphia store. Thanks to radio, a theft was prevented and a clever impostor exposed.

E. H. Felix

Grandma Listens In

WHAT happens when an inexperienced hand tries to tune in on the receiver is told in this item that comes from Albany, New York:

Grandma made a startling discovery the other night. She had often taken the head phones to listen in on a broadcasted program, but she did not know what code signals sounded like.

My cousin Henry had just erected a station, and we were in communication with him for the first time. Grandma was much elated when I was actually talking to Henry through the air. Although his code signals were faint they were distinguishable, and I let Grandma take the phones to hear Henry for herself. She listened for some time but said she could hear nothing. I turned the knobs of my condenser and my variable inductance for better adjustment, but still she frowned. I concluded that the trouble was with her hearing, so I began to couple in a second vacuum valve to make the signals stronger.

As I went about finding the proper wires and connections, Grandma took it upon herself to turn the knob of the inductance, as she had seen me do. She tuned the set so broadly that dozens of stations could be heard.

"Ralph!" she exclaimed. "Someone is broadcasting a cat fight!"

Ralph Somers

¶ *The story of the first human being to receive and to send a radio signal—the pioneer scientist who ante-dated the great men whose names are household words today—will be told in the next number of* POPULAR RADIO.

JUN 25 1927

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Popular Radio

SEPTEMBER, 1922

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How to Build the New Armstrong-Circuit Receiving Set

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When Marconi heard the AERIOLA GRAND

© UNDERWOOD & UNDERWOOD

"IT comes closest to the dream I had when I first caught the vision of radio's vast possibilities. It brings the world of music, news and education into the home, fresh from the human voice. It solves the problem of loneliness and isolation.

"The Aeriola Grand is at present the supreme achievement in designing and constructing receiving sets for the home—a product of the research systematically conducted by scientists in the laboratories that constitute part of the R C A organization."

G. Marconi

The Importance of the Symbol R C A

CRUDE radio apparatus of a kind can be made even by embryonic organizations. But the vitally important inventions that have made radio the possession of every man, woman and child are those protected by patents owned by the Radio Corporation of America and developed as the result of costly research conducted in the engineering laboratories of the Radio Corporation of America.

The name plate of a Radio Set is all-important in the purchase of radio apparatus. If it bears the letters "R C A" the public and the dealer are assured that at the time of its introduction it is the highest expression of the advancing art of radio.

In tone quality, in simplicity of manipulation the Aeriola Grand is unrivalled. A child can snap the switch and move the single lever that tunes the Aeriola Grand and floods a room with song and speech from the broadcasting station.

Any R C A dealer will be pleased to show you the Aeriola Grand and to let you judge its wonderful tone quality for yourself. There is an R C A set for every purse—Prices range from $18 to $350.

Aeriola Grand with stand $350

Radio Corporation of America

WORLD WIDE WIRELESS

Sales Dept., Suite 2067
233 Broadway
New York City

District Office
10 South La Salle St.
Chicago, Ill.

Announcing—
Bel-Canto
The Superlative Loud Speaker

Photo by Paul Thompson

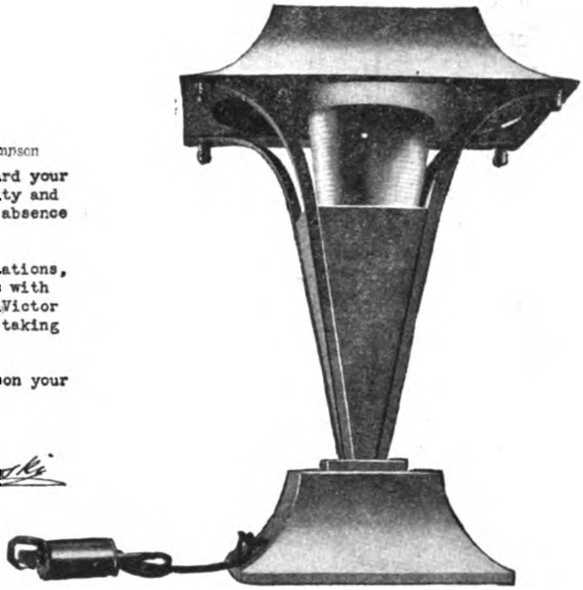
It was with great pleasure that I heard your Bel Canto loud speaker, the other day. The clarity and volume of tone transmitted, and particularly the absence of sound distortion make it a remarkable device.

While listening to different radio stations, some of them far away, I heard music and lectures with surprising distinctness, and the reproduction of Victor records sounded to me as if the performance were taking place in the same room.

You are indeed to be congratulated upon your ingenious invention.

Truly yours,

I. J. Paderewski



HERE, at last, is the perfect loud speaker — the Bel-Canto. Not simply "another" loud speaker, but an entirely new instrument, endorsed for its remarkable volume and beauty of tone by one of the world's greatest musicians—Paderewski.

The Bel-Canto reproduces perfectly and without distortion, and, unlike other loud speakers it disperses the sound in *all directions,* filling the entire room.

The Bel-Canto is a thing of beauty, sturdily constructed and handsomely finished in dull lacquer. It comes fully equipped with a special, extra-sensitive, imported, loud-speaking phone, silk-covered cord, and hard rubber plug —all ready to attach to your set. There are no "extras" to buy.

The Bel-Canto is constructed of reeds and brass in strict conformity to every known principle of acoustics. The sound is purified in a specially constructed chamber before being conducted through the reed amplifying tube to a brass resounding chamber. The result is a tone of such clarity and mellowness as to surpass any other amplifying device on the market—even those selling at $100 or more. Yet the price of the complete Bel-Canto is only $30.

Ask to hear the Bel-Canto at your dealer's. If your dealer has not yet stocked the Bel-Canto, we will forward you the complete instrument prepaid on receipt of check or money order for $30.

Bel-Canto Corporation, 417 East 34th Street, New York

Jobbers and Dealers—write for our proposition

POPULAR RADIO

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(Cover design by Adolph Treidler)

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KENDALL BANNING, *Editor*

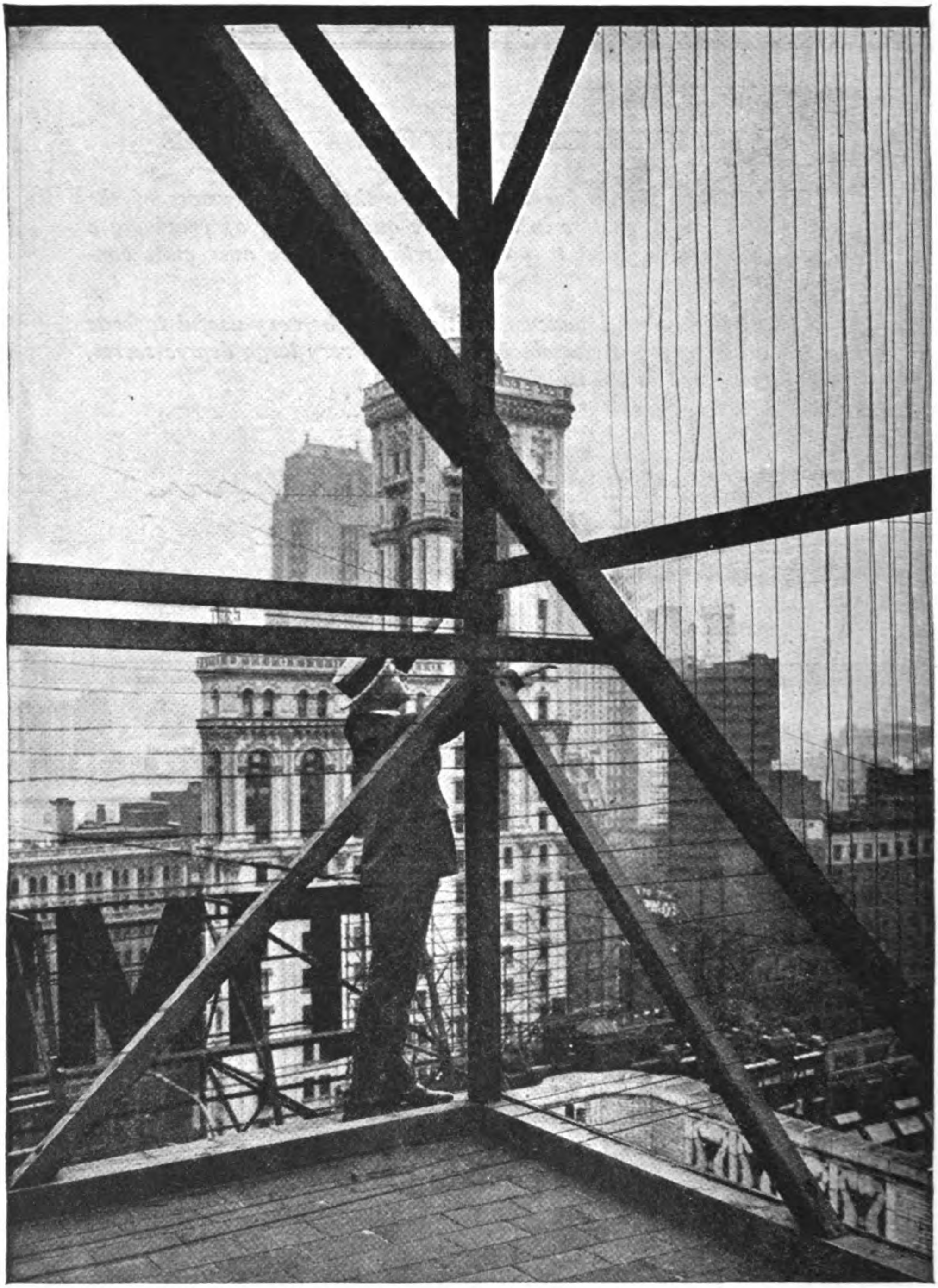
E. E. FREE, PH.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

The COMING USE OF SHORT WAVELENGTHS

"IT *has been shown for the first time that electric waves of the order of* 15 *to* 20 *meters in length are quite capable of providing a good and reliable point to point directional service over quite considerable ranges.*

"In these days of broadcasting it may still be very useful to have a practically new system which will be to a very large degree secret, when compared to the usual kind of radio."

G Marconi.



From a photograph made for POPULAR RADIO

A POST THAT LISTENS IN ON EUROPE

On this giant loop—a part of the aerial system atop the offices of the New York Times. —are received daily about 5,000 *words of news items from the radio stations at Bordeaux, France (LY,* 23,200 *meters), Hanover, Germany (OUI,* 14,500 *meters), Nauen, Germany (POZ,* 12,600 *meters), and Leafields, England (GBL,* 12,300 *and* 8,750 *meters).*

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Popular Radio

VOLUME II SEPTEMBER, 1922 NUMBER 1

The Battle in *the* Air Lanes

A HERETOFORE UNWRITTEN CHAPTER OF AMERICAN HISTORY

This article gives an intimate glimpse behind the scenes of the greatest war in all history. One of the most dramatic and vital phases of that war was the fight for the Public Opinion of the allied, the neutral and the enemy nations—a fight which developed in a colossal struggle that reached to the farthermost ends of the earth, and much of which is here revealed for the first time. And in this struggle the commanding and the decisive rôle was played by the radio.—EDITOR

By GEORGE CREEL

NOTHING is more amusing than to watch science make fools of politicians. Even today, while certain Senators are jealously guarding America's "detached and distant situation," and thinking of the United States in terms of Chinese walls, the radio has made Europe and the Orient our next door neighbors—almost to the extent of gossiping over the back fence.

Fast steamships marked the end of national isolation; cables pushed the good work still further along. But it has remained for radio to smash the superstition until there is not enough of it left to take up with blotting paper. Right now our communication with every foreign government is easy and direct, and with the thousand and one advances that are constantly being made, it will eventually be as simple to communicate with a country half way around the globe as to telephone from one country farm to another.

It is impossible to overstate the changes that radio is going to work in the whole scheme of international relationship. World trade, of course, will be revolutionized by the instancy and cheapness of wireless. But even this obvious gain is infinitely less important than other gains too great to be measured in money. Before science has finished with radio it will have wiped out boundary lines as far as the thought and friendship and understanding of peoples are concerned.

Today, while their governments bicker at "conferences," the radio amateurs of Europe are talking one to the other, establishing contacts that will grow and grow until there is an end to these petty social hates that are bred and fostered in misinformation and misunderstanding. "How could I hate him if I knew him?" is as true now as when Sidney Smith uttered the words.

Already there are signs of the coming revolution. Study your newspaper these days and you will notice a vast increase in the amount of foreign news. If you were to see a European or Oriental daily, you would, in turn, observe an amazing improvement in the number and length of news items about the United States. Radio is almost entirely responsible for the change. The high cost of cable tolls is no longer a barrier against the exchange of news, and the lower rates of radio are commencing to infuse the great press associations with new energy and ambition.

Never doubt that this is not going to exert a powerful influence on international relations. When the citizens themselves know day by day what the citizens of another country are doing and thinking and saying, politicians will have a sad time attempting to play on ignorances and outworn hates. News—not propaganda, but real news—is about the best binder that the human family has ever developed. We proved it during the war and we proved it by radio.

Much of the war work of radio is well known. Its varied and important employment by the military and naval establishments has been completely disclosed, and the miracle of it all is now commonplace. An even larger use of wireless, however, is little understood. In the fight for "the verdict of mankind"—propaganda, to use the hackneyed word—America put her chief dependence on radio, finally reaching a peak of operation that used the air lanes of the whole world, reaching every country on the globe with the American message. Germany's collapse was moral as well as physical, and in this disintegration of enemy morale, radio was the principal and the determining factor.

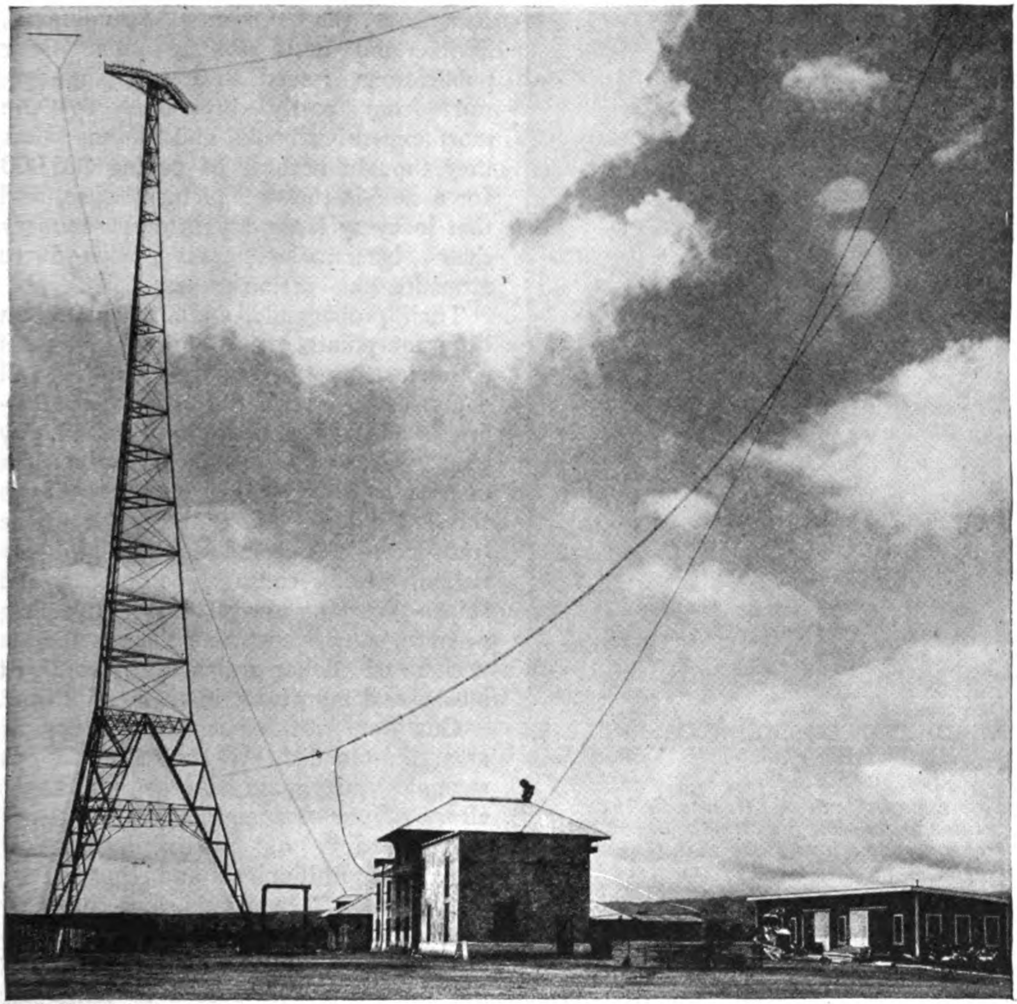
It was in recognition of Public Opinion as a major force that the Great War differed most essentially from all previous conflicts. The trial of strength was not only between massed bodies of armed men but between opposed ideals; moral verdicts took on all the value of military decisions. Other wars went no deeper than the physical aspects, but German Kultur raised issues that had to be fought out in the hearts and minds of people as well as on the actual firing-line. This was the fight that the Committee on Public Information was called upon to make.

The domestic task was simple compared with the undertaking that faced the Committee when it turned from the United States to wage the battle for world opinion. It was not only that the people of the Allied Powers had to be strengthened with a message of encouragement, but there was the moral verdict of the neutral nations to be won and the stubborn problem of reaching the deluded soldiers and civilians of the Central Powers with the truths of the war.

It was a task that looked almost hopeless. The United States alone of the great nations of the world had never engaged in propaganda. For years preceding the war Germany had been secretly building a vast publicity machine in every corner of the earth, designed to overwhelm all foreign peoples with pictures of Germany's vast power, her overwhelming pre-eminence in industry, commerce and the arts. German agents, carefully selected from among her journalists and authors, neglected no opportunities for presenting Germany's case to readers of every language, and her commercial firms linked a propaganda of liberal credits with this newspaper campaign throughout the world.

Great Britain, through Reuter's news agency, likewise conducted a governmental propaganda. France had official connection with the Havas Agency. Both England and France, through ownership or liberal subsidy of certain great cable arteries, had long been able to direct currents of public opinion in channels favorable to themselves. Other nations had publicity machines of varying types.

America controlled no cables, manipulated no press associations, operated no propaganda machinery of any kind. We were and always had been dependent upon foreign press agencies for inter-



U. S. Navy, Official

THE NAVAL RADIO STATION THAT LED AMERICA'S FORCES OF PUBLICITY INTO CHINA

From San Diego was sent America's war message to the Orient—by way of Pearl Harbor and the Philippines. The military value of radio in disseminating news of America's war activities was "worth more than a million soldiers."

course with the world. The volume of information that went from our shores was comparatively small; after it had been filtered in London or Paris it grew smaller and smaller until it amounted to mere "flashes" when it reached a far country. Strangely enough, we were at once the best-known and the least-known people in the world. There was no corner of the globe in which America was not a familiar word, but as to our aims, our ideals, our social and industrial progress, our struggles and our achievements, there were the most absolute and disheartening misunderstandings and misconceptions. For instance, when some "gun-men" were executed in New York, papers in South America actually printed accounts that told of an admission fee being charged, with Governor Whitman taking tickets at the door!

The Germans projected themselves into this situation with vigor and decision. From the first, Berlin had an exact ap-

Brown Bros.

HE DIRECTED AMERICA'S FIGHT IN THE ETHER FOR "THE VERDICT OF MANKIND"

To a remarkable degree George Creel was in a position to see—and did see—the urgent need of presenting America's purposes in the war to the peoples of the world and of counteracting Germany's intensive and ruthless propaganda. In this article he reveals for the first time to what an amazing extent we relied upon, as our chief weapon in combating these forces, the most far-reaching and powerful of agencies—the radio.

preciation of the military value of public opinion, and poured out millions in its endeavor to win or else to corrupt it. It is impossible even to estimate the amount of money spent on propaganda by the Germans. Russians competent to judge assured us that the agents of Berlin spent $500,000,000 in that country alone, and their expenditures in Spain were estimated at $60,000,000. Close to $5,000,000 went to Bolo Pasha for the corruption of the Paris press, and the sums spent in Mexico ran high into the millions. I knew that they owned or subsidized dailies in most of the important cities of Spain, South America, the Orient, Scandinavia, Switzerland and Holland; that their publications, issued in every language, ran from costly brochures to the most expensive books and albums; that they thought nothing of paying $25,000 for a hole-in-the-wall picture house, and that in every large city in every country their blackmailers and bribe-givers swarmed like carrion crows.

Their propaganda, while playing upon different points of prejudice in various countries, was much the same in all countries. As an initial proposition America's military strength was derided. By no possibility could the United States raise or train an army, and if, by some miracle this did happen, the army could not be transported. America was a fat, loblolly nation, lacking courage, equipment, and ships. Working away from this pleasing premise, Americans were described as a nation of dollar-grabbers, devoid of ideals, and inordinate in their ambitions.

Our war with Mexico was played up as a cold-blooded, evil conquest and our struggle with Spain was painted as an effort of our financial masters to enter upon dreams of world imperialism. Cuba, the Philippines and Porto Rico were pitied as "America's slave nations;" Pershing's expedition to Mexico was declared to be the start of a war of conquest that we were later forced to relinquish because our "cowardice" shrank before the "dauntless" courage of Carranza. The Colorado coal strike, the Lawrence strike and the Paterson strikes were all treated in the utmost detail to prove America's "system of wage-slavery;" pictures were drawn of tremendous wealth on the one hand and peonage on the other; lynchings were exaggerated until it was made to appear that almost every tree in America was used for purposes of execution, and we were charged in every conceivable form and fashion with being the secret partner of one or the other of the Allies in commercial plans to control the trade of the world.

Where there was French sentiment, America was set down as "the secret partner of England." Where English sentiment prevailed, we were the "secret partner of France;" and where Italian sentiment obtained, America, England and France were assumed to be in a plot to destroy Italy.

In Spain every effort was made to revive the prejudices and passions of 1898, and the pro-German press ran daily lies in proof of "Yankee contempt for the Spaniard." One falsehood was that a favorite American recruiting slogan was: "Enlist for the War! Remember the Maine and Spain."

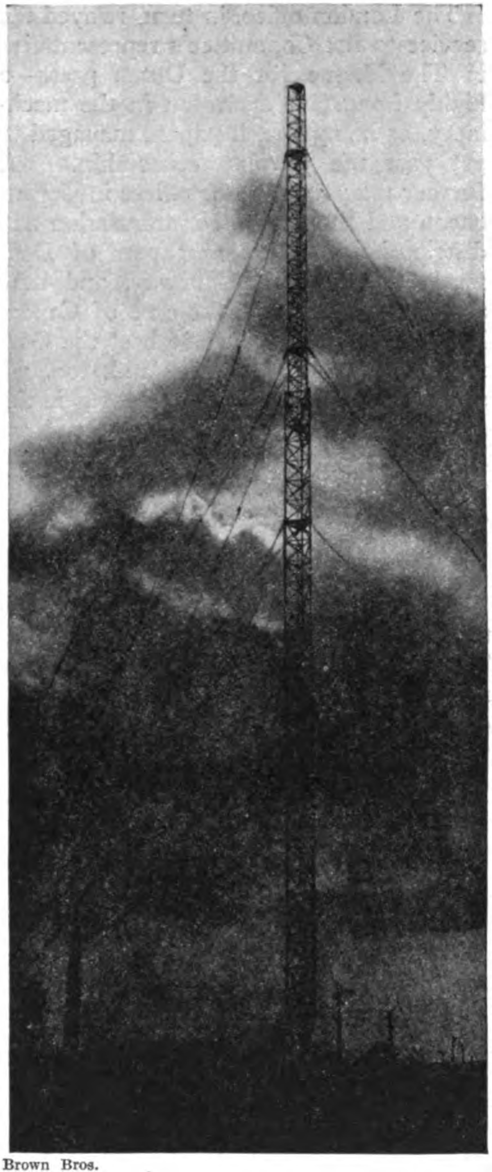
When we first set about the creation of a news machinery to carry American facts to the world a natural reliance was placed upon cables—the one established medium for international communication.

The cables, however, were virtually all foreign owned. The cable rates were prohibitive; what was even more conclusive, all of them were so overburdened as to endanger vital war business by their delays. Forced to look in some other direction, our eyes fell upon the wireless, taken over by the navy some time before and lying idle for a good part of the time. Without more ado, we put our problem before the Secretary of the Navy, Mr. Josephus Daniels, who straightway placed the wireless stations of the United States at our disposal, likewise the expert navy personnel under Captain David Todd.

Offices were taken in New York, a news force was gathered and in September, 1917, the "Compub" (as its code address soon advertised it to the world) commenced business.

The first radio service was from Tuckerton to the French wireless station at Lyons. From Lyons by arrangement with the French government it went to our office in Paris, and after translation and distribution to the press of France, it was relayed to our offices in Switzerland, Italy, Spain and Portugal.

The next step in the world dissemination of news came through arrangements heartily entered into by the British government. The same wireless report sent to Lyons was intercepted by navy operators at the American naval base and was relayed to London, where the representatives of the Committee received it and distributed it to the English press.



Brown Bros.

WHERE THE FIRST GUN WAS FIRED

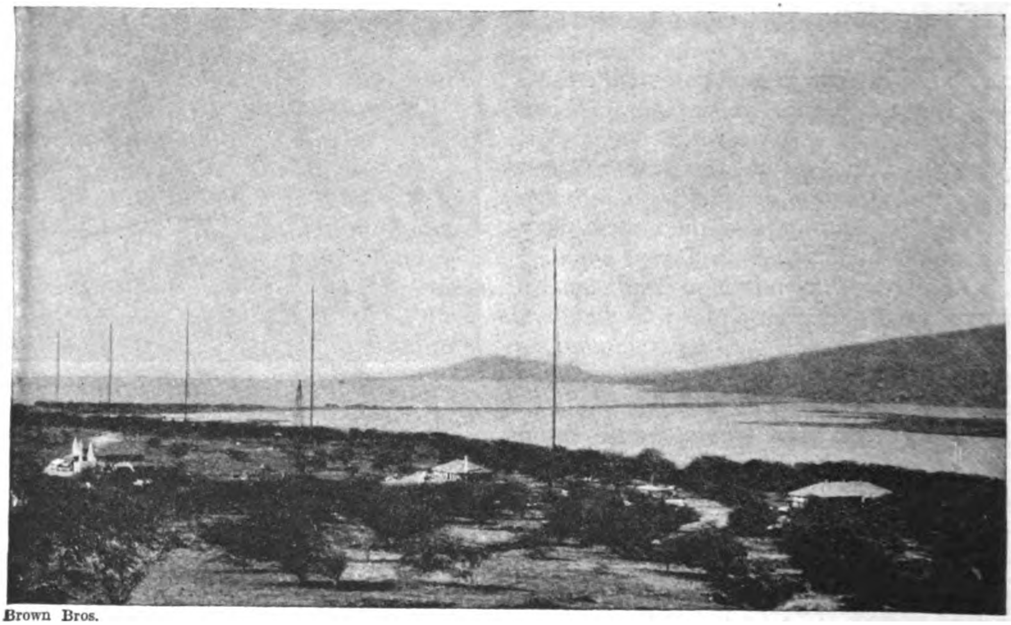
In America's fight for public opinion the first propaganda to be sent out by radio was broadcasted from the station at Tuckerton, New Jersey. It was relayed via Lyons to Paris.

The London office, in turn, relayed the service to the Committee's representative in The Hague for the Dutch press—a highly important operation in the machinery, as many Dutch papers managed to get past the German censorship. A further relay was to our offices in Copenhagen and Stockholm for translation and distribution to the newspapers of Denmark, Sweden, and Norway, and here again, particularly in the case of Copenhagen, we had a chance to beat the German censors. In Switzerland, too, we scored heavily against the Germans in the same fashion. The service also went from London to Saloniki and other Greek points, for not only was Greece to be considered, but it was good ground from which to shoot into the Balkans.

Our first effort to serve Russia was by wireless, and after much experimentation under the direction of Captain Todd we were actually able to reach the Russian station at Moscow. This service, put into Russia for the press, for the billboards and even on the movie screen, was relayed town by town all the way from Petrograd to Siberia. When the Bolsheviki overthrew Kerensky, however, one of their first actions was to grab the wireless stations. The one at Moscow, either intentionally or through ignorance, they put out of operation. The wireless station at Cracow, in Poland, was inefficient at first, but towards the last managed to receive, although sending continued to prove a failure.

Continued pressure upon the Italian government finally resulted in wireless improvements to such a degree that the station in Rome was able to receive directly from Tuckerton. This did away with the necessity of relay from Paris and enabled the New York office to pour a daily stream of news straight into Italy, an immediate contact to which the Italian press responded enthusiastically.

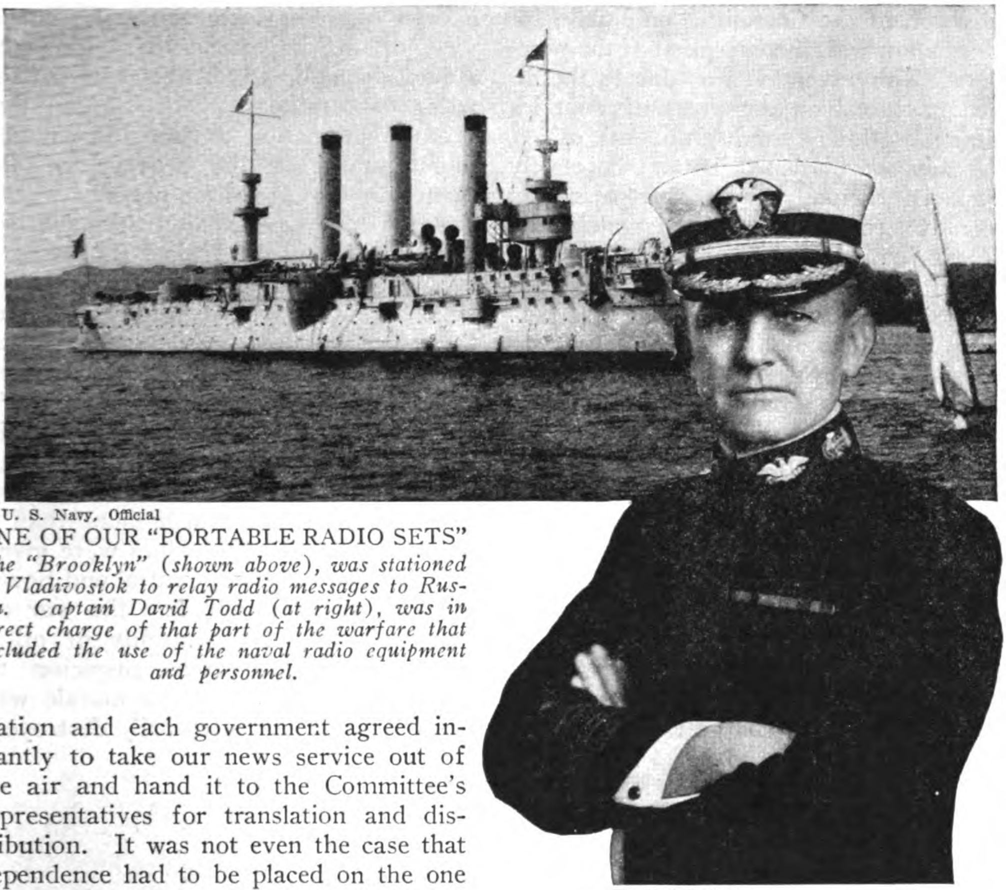
With Europe accounted for, attention was next given to South and Central America. Virtually every South and Central American country had a wireless



Brown Bros.

A REMOTE LINK IN UNCLE SAM'S RADIO CHAIN AROUND THE EARTH

Even in such far away outposts as this, at Koko Head in the Hawaiian Islands, the radio operators were able to serve their country by carrying on her valiant fight for "the verdict of mankind."



U. S. Navy, Official

ONE OF OUR "PORTABLE RADIO SETS"

The "Brooklyn" (shown above), was stationed at Vladivostok to relay radio messages to Russia. Captain David Todd (at right), was in direct charge of that part of the warfare that included the use of the naval radio equipment and personnel.

Harris & Ewing

station and each government agreed instantly to take our news service out of the air and hand it to the Committee's representatives for translation and distribution. It was not even the case that dependence had to be placed on the one wireless leap from Tuckerton, for there was our high-power station on the Isthmus of Panama to act as a relay. Mr. John Collins, "borrowed" from the Panama Canal Board, handled Central America from Darien, broadcasting it for interception by the wireless stations of the United Fruit Company.

The next link in the world chain was the Orient. "Compub" opened a branch office in San Francisco and commenced the preparation of a daily service of particular interest to China, Japan, the Philippines, and Hawaii. The navy wireless station at San Diego flashed this to Pearl Harbor for distribution to the Hawaiian press, and from Pearl Harbor it was flashed to the Philippines. Our original theory was that the Chinese and Japanese stations would receive from Manila, but owing to many mechanical difficulties it became necessary for our own station at Guam to take the service out of the air and put it on the cables to Shanghai and Tokio. In China the service was distributed through a specially organized chain of newspapers, and in Japan we worked through the Kokusai and Nippon Dempo, the two principal news associations. From Shanghai the service was relayed to Vladivostok, where our office gave it Siberian circulation. Distant Australia picked the service out of the air and used it.

The installation of "Compub" at Vladivostok, Harbin, Irkutsk, and Omsk in Siberia enabled us to send a direct Russian service from the wireless station at San Francisco.

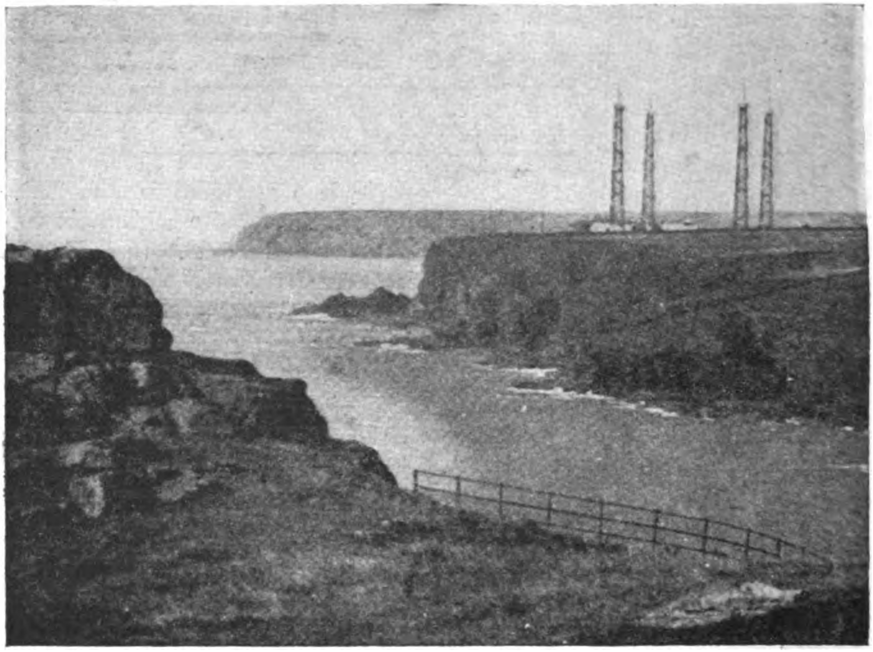
Immediately upon the signing of the armistice, orders were given to close every division of the Committee on Public Information with the exception of the wireless. This exception was due to the dilemma in which the press of America found itself. The four transatlantic cables, already overburdened, became hopelessly jammed when an army of newspaper men commenced to file daily despatches in Paris for quick transmission.

To meet the situation, Mr. Walter S. Rogers, director of the Committee's Foreign Wireless and Cable Service, was placed unreservedly at the disposal of the correspondents, and directed to find a "way out." As a first measure to lighten the cable load, the committee agreed to radio to the United States all formal statements, speeches of the President, and other like matter requiring textual sending, and to make simultaneous delivery in New York to the press associations.

A second step was in the direction of aid to individual correspondents. The Navy, in charge of the wireless, was forbidden by law to charge tolls, nor could it even receive private messages; but in view of the importance of giving the American public all possible news of the peace deliberations, it was agreed that the Committee on Public Information might undertake the delivery of the matter to the American press.

After many negotiations the French government and the United States navy entered into an arrangement through which the Committee was able to offer thirty-five hundred words daily on the wireless, absolutely free of charge, to the American correspondents in Paris.

Such, then, was radio's war record in the fight for the "verdict of mankind," in which, as a well-known statesman expressed it, "it was worth more than a million soldiers." The Allies were given new courage and hope, Central and South America were brought into the war on America's side, the neutrality of other countries changed from suspicion to friendship, and the German morale was steadily sapped and eventually destroyed.



Keystone View Co.

RADIO LOOK-OUTS AGAINST ENEMY SUBMARINES

Day and night these vigilant sentinels listened in at Lands End, England, for communications between German and Austrian naval vessels. Only the records of the government will reveal the invaluable service they rendered.

From a photograph made for POPULAR RADIO

A LIVE NEWS STORY IN THE AIR

The newspaper of the near future will not depend solely upon wires for collecting its information. Today stories are being received by city editors from reporters miles away who use radio-equipped motor cars. This picture shows W. F. B. McNeary of the Newark Sunday Call, receiving a news item by radio.

The Newspaper that Comes Through Your Walls

The "Radio Newspaper" Is No Longer a Theory; It Has Arrived—Abroad. In This Country the Wireless Is Being Used Both for Collecting and Disseminating News. This Article Tells How.

By HOMER CROY

IN Budapest there is a newspaper that has no printing presses and no newsboys. It is a large and flourishing newspaper and, as far as I know, all its subscribers are satisfied. It has never been "scooped" and there is little likelihood that such a catastrophe will soon happen. It begins to give its news to the public at nine o'clock in the morning and it does not stop until ten o'clock in the evening. On opera nights it does even better; on such occasions it stretches its service a little and gives its subscribers the opera.

The newspaper is called *The Telephone-Hirmondo* and has been in existence for twenty-eight years.

As its name implies it is a telephone newspaper. It furnishes news direct to its subscribers by an elaborate system of party lines. All a subscriber has to do is to step to the telephone and put the receiver to his ear. To each subscriber is furnished a schedule showing the hours different news goes out: local, national, world news, sports, fashions. Fiction stories are read to the subscribers, speeches are delivered; puzzles are told and English is taught to all who wish to learn it. Even serials running in local motion picture shows are read to subscribers; that night a person may go to the theatre and see for himself the story his newspaper has told him. Budapest's telephone newspaper is not an experiment; not some vague, uncertain, half-baked theory. It has been a success for more than a quarter of a century.

Germany is a step ahead of this! Just outside Berlin the German government has a newspaper that instead of sending out news by telephone, sends into the air. At certain hours it sends out government news, political news, sports and so on. But Germany rules its radio with a heavy hand; in this regard it takes itself very seriously. Every radio set which goes out is licensed and watched. The person who installs the set is allowed to receive but one kind of news; the government authorities see to that and lock the box. This is done by sending out different kinds of news on varying wavelengths; the owner of the set can receive only the kind his license calls for.

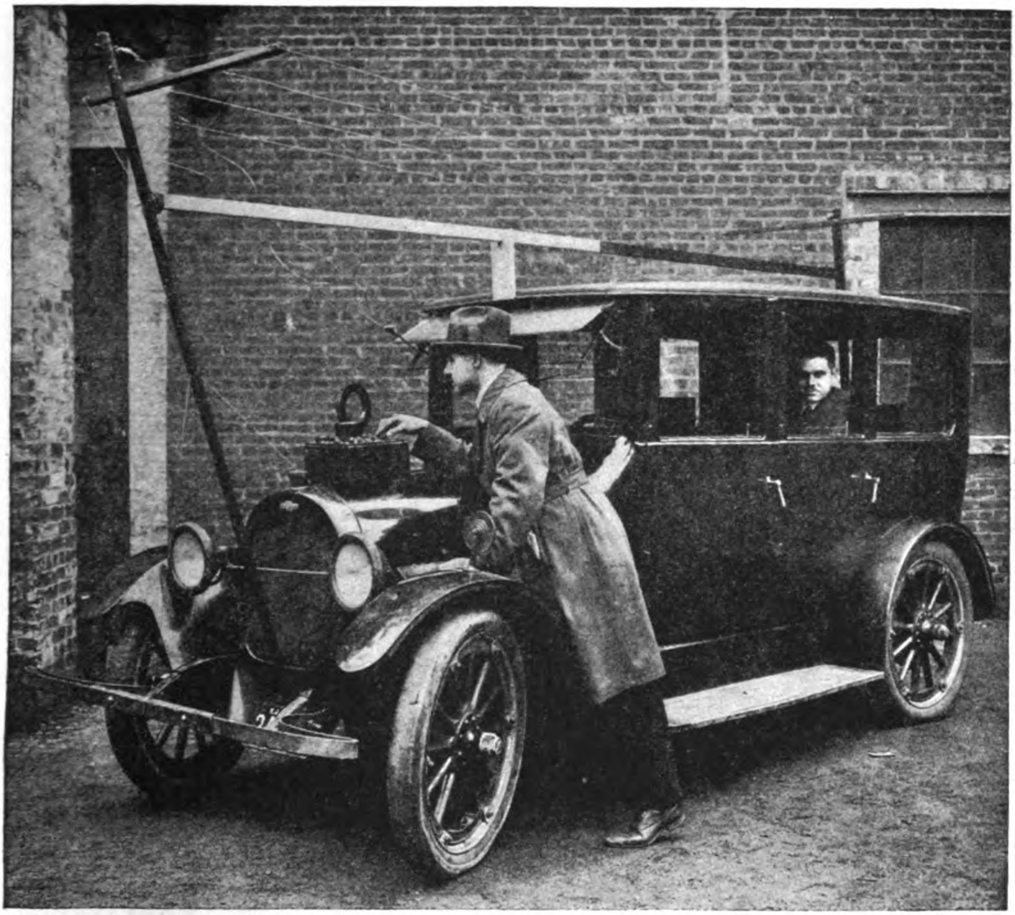
We would not stand for that in this country, but just the same there is an idea behind it—the radio newspaper is coming. It is assured. France and Italy both have been watching Germany's experiment with the radio newspaper and now are planning to install equipment for disseminating news—but on a much more liberal policy.

The United States has never gone into the radio newspaper as a governmental proposition, but in this country our newspapers are far and away ahead of European newspapers—when it comes to hitching up to radio of their own accord. Over there they are just beginning to scratch their heads and wonder if there isn't something in the idea, while in this country eight of ten individual newspapers are actually broadcasting.

It will be recalled that last summer the world was awaiting the outcome of a

THE PRESS GALLERY AT THE FIRST FOOTBALL GAME EVER BROADCASTED

The reporter using the telephone is "Sandy" Hunt, former Cornell guard, reporting the first intercollegiate contest that was ever described by radio, play by play, in October, 1921. The story was sent from the field to the operating room of station WJZ at Newark over a private wire, whence it was broadcasted. Several intercollegiate games were similarly reported later that season.



From a photograph made for POPULAR RADIO

THE FIRST AUTOMOBILE TRANSMITTING STATION TO BE LICENSED

Equipped with a radio transmitting set, this car was sent out on a news assignment by the Newark Sunday Call on May 6, 1922—the first recorded instance of its kind. The car bears the call letters 2CNJ. In the picture Emery H. Lee, the radio inspector is seen measuring the wavelength, which was exactly 200 meters.

battle in Jersey City, where two men were stripped to their waists to fight for life or death. In all parts of the country the hours were counted on that day when Messrs. Dempsey and Carpentier drew crowds of excited fight fans to Boyle's Bowl. Newspapers found that there was but one "story" for them that day—all other happenings were small "items."

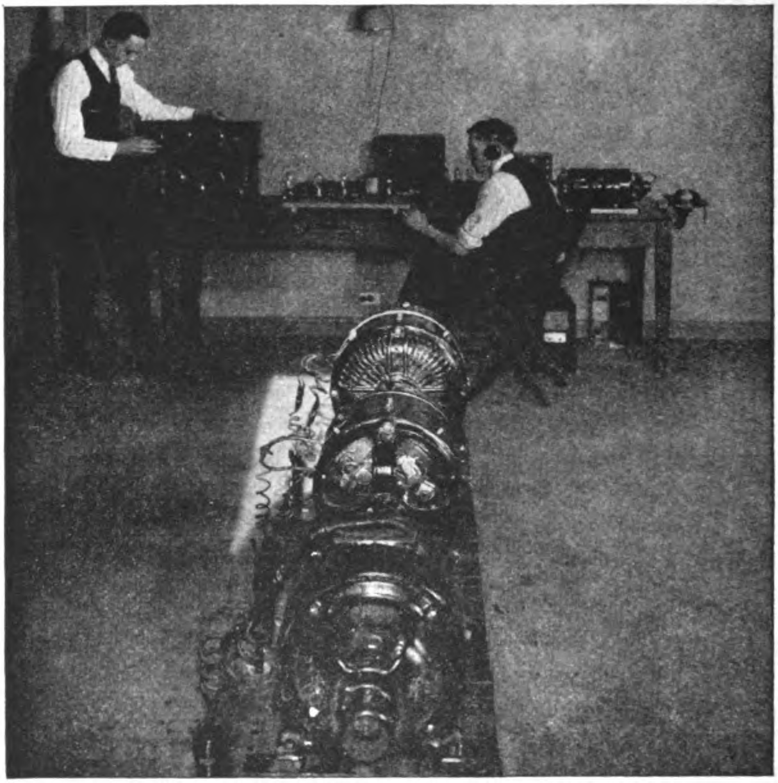
The Seattle Post-Intelligencer had an idea. Why not get the news to the people in and around Seattle fast—faster than presses could run? It was the first time such a thing had ever been tried. Steam was put behind it and arrangements were made with a local radio distributing company, and a sending outfit was engaged for the day. The paper spread it on the first page and Boyle's Bowl was practically taken up and dumped down in Seattle. The people in that city were almost as close to the two heated gentlemen as were the owners of the fifty-dollar seats. The fight was practically as much of a success in Seattle as it was in Jersey City. After the final and lamented fourth round, the paper thought the excitement was over; they told the radio company to come and take the equipment away.

But the next day the letters began to

pour in. Why couldn't the paper give the subscribers news by radio all the time?

That would be biting off a big chunk, especially in view of the fact that never before had such a news service been rendered. But the newspaper sank its teeth and pried off an experiment. Now on top of the building it has a radio room and tower antennae 105 feet tall. Six hours a day it sends out news—anything, everything. It furnishes music for charity dances, civic organizations, luncheon parties, entertainments for graded schools to raise funds for baseball suits, entertainment for disabled soldiers, music and speeches for patients in hospitals; for style shows, hardware meetings and even helps teach radio in the high schools of the state. Every Friday night it hires an orchestra, brings it to its own sending room and puts on a dance program. Friday night radio dances are now being held not only in Seattle, but in Spokane, San Francisco, Portland, Vancouver, B. C., and even in Craig, Alaska. As if this were not enough, word came from a ship on the Pacific that its passengers had shaken a wicked foot in response to the same tintinnabulations. On top of this the Chamber of Commerce in Butte, Montana, wanted to have a social where their wives and sweethearts could be brought together. The radio brought them——.

At first it was thought that only residents in and around Seattle would be able to hear the radio programs, but such was



THE POWER PLANT OF THE RADIO STATION OF A MIDDLE-WESTERN DAILY

One of the best-equipped transmitting stations in the country is WWJ, maintained by the Detroit News for broadcasting both entertainment and news features. The picture shows the 5½ H.P. motor, driving a 1600-volt, 1-kilowatt plate current-generator and a 16-volt, 615-watt filament current-generator, providing power for the transmitter tubes.

REPORTING A WORLD'S SERIES BY RADIO

The sporting editor, G. A. Falzer, is here seen using an ordinary telephone for reporting the baseball games at the Polo grounds, New York, in 1921. But his telephonic talk went to a transmitting station, where it was broadcasted.

not the case. The *S. S. Montgomery City* was 3,600 miles out in the Pacific when it picked up Seattle, and messages inland have gone as far as Minot, N. D. When the paper started its broadcast there were only 284 receiving sets within range; now, it is estimated, there are 20,000. That is how things have moved along in the world of radio.

In the meantime the wheel of progress was rolling on in other parts of the United States. Newark, for instance, where you would not expect to find much hustle. And the experiment in radio was not by a daily, either, but by a Sunday paper—*The Newark Sunday Call.*

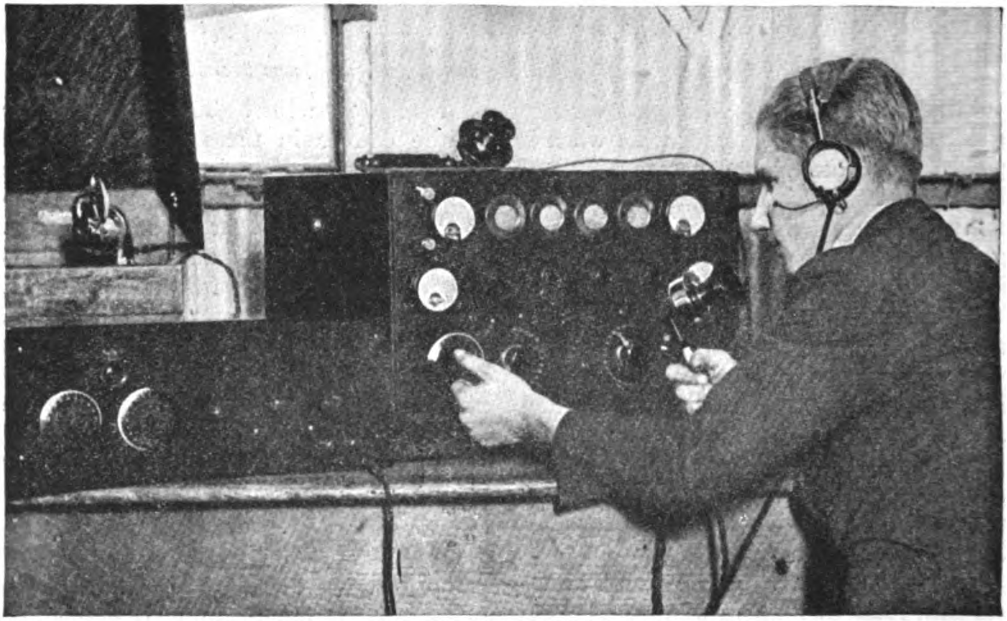
The World's Series came along, October 5th, 1921, and a man went to the Polo Grounds and there put the news on a telegraph line. In the office of the *Sunday Call* it was taken down and then hustled on a telephone line. This came to one of the editors in the newly established broadcasting station of the Westinghouse Company and there the man spoke into the transmitter and sent it up into the air.

The experiment was a success. Things began to move along for the paper and it originated bedtime stories for children, and started broadcasting news. This went out about half-past eight in the evening. It made such a success of it that the paper began broadcasting in the day time, beginning at ten o'clock in the morning and continuing throughout the day on the hour. Broadcasting breathed the breath of life into amateur radio, and on October 16th this paper started a radio department of two pages—the first radio section started by a newspaper. The people couldn't get enough of it. It was not long until a New York paper took a nibble—and then sank its teeth. Radio departments sprang up with the speed credited to toadstools, although personally I have never seen one do this amazing feat.

Newspaper after newspaper started departments until now two New York newspapers get out a whole magazine section each Saturday devoted to the wonders of wireless. But they were not content for long merely to run programs and conduct departments. *The Detroit News* began to broadcast; others began to itch, and now *The Hartford Courant,* started before the Revolutionary War began, has felt the urge of the latest departure in journalism. Other papers are taking it up; soon, no doubt, a metropolitan newspaper which does not broadcast will be considered quaint and a bit inclined to old-fashioned ways.

Two things may happen, and both of them, it must be known, are entirely in the realm of speculation. There is no definite fact to substantiate it—only a few straws blowing in the wind. In the future the newspapers will broadcast in their territories. St Louis will have newspapers sending out their silent appeals on different wavelengths; Omaha will be doing the same; Waco, Wheeling, Woonsocket. They will send out local news. For example: "George Washington Jones, the millionaire manufacturer of folding wash boards, was arrested this afternoon for speeding and was fined $4." The license numbers of stolen automobiles will be given out and the police departments will be assisted in recovering the missing property, as they have been already in several cities. Local, grain and crop markets will be sent out; whether wheat is up or down, what activity potatoes show and what chickens are doing — the domesticated variety, that is. Gossip, sports, local news items will go out.

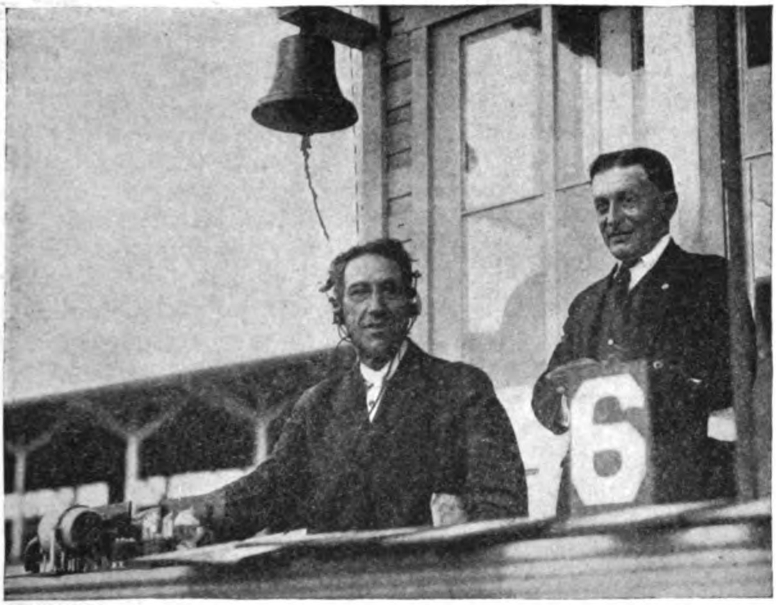
On the other hand, a national newspaper may be established to send out on a different wavelength entirely different matter—news of national and international interest. Those who wish to hear about some peace parley in Europe can hook onto the big newspaper; those interested



International

A DAILY NEWSPAPER THAT SENDS OUT NEWS BY RADIO

The San Francisco Examiner broadcasts both local items and news of national moment from its station in the Examiner Building, as well as the usual weather reports and market quotations.



© Harris & Ewing

THE FIRST TIME THAT A HORSE RACE WAS BROADCASTED

The methods of the race-track crooks who swindle guileless bettors by "tips" over private wires will have to change when racing news is reported by radio. The officials at the Bowie (Maryland) track recently transmitted the results of the races by radio—although in this particular picture the results are apparently being transmitted by a receiving set.

in home affairs can give the knob a twist to "local." The national newspapers will have the biggest and most famous contributors—even the President may use it.

But, anyway, the radio newspaper era is coming. How soon? No one knows. Maybe next year. This time last year no newspaper knew that it could broadcast; now the air is full of them. It would be no greater surprise than what has happened in the past year.

The newspaper reporter of the future will not go on the subway, or pegging along in a trolley. He will have his own automobile. Is there a wreck? A shooting? A catastrophe? The reporter will merely plant his ground wire and with his small sending set send the news back to the office. Other reporters will be out gathering up different threads; securing interviews, running down the police end of it. The "city room" will coordinate and simplify these reports. A re-write man will put it all in a connected story and then hand it to a stentor. The stentor will carry it to the sending room and up it will go into the ether. While the people are still being taken out of the wreck, those in their homes for hundreds of miles around will know about it.

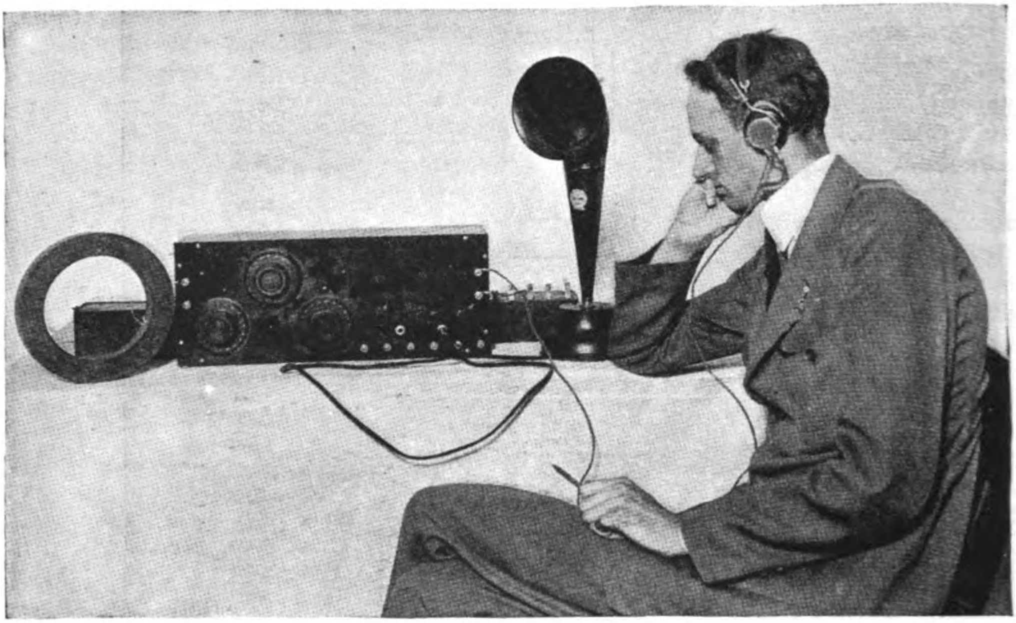
> "The building is still burning. Firemen with their oxygen helmets are feeling their way through the smoke . . . A child has been found . . . It is alive . . . It's mother is weeping"——

So the reports of the future will go out.

The idea seems fantastic? So did the application of radio to Boyle's Bowl a year ago.

There is only one safe bet about radio; and that is not to try to judge its future by its past.

¶ *Another amazing development of radio is in the hospital service, particularly in rendering medical care to men at sea. Many a marine owes his life to "Old Doctor KDKF"—whose original methods of looking after his patients will be told in another article.*



From a photograph made for POPULAR RADIO

THE NEW SUPER-REGENERATIVE SET IN USE

This receiver employs three hard vacuum tubes and receives signals of extraordinary strength on a small circular loop antenna—shown at the left of the above picture. The set is complete as shown above.

How *to* Build *the* New Armstrong-Circuit Receiving Set

No recent development in the field of radio has attracted anything like the attention or has so directly affected the radio amateur as the super-regenerative receiving set invented by E. H. Armstrong. The apparatus is in effect a regenerative circuit in which the ordinary limitations to amplification have been overcome—specifically by eliminating self-oscillation while at the same time increasing regeneration. Because of the extraordinary degree of amplification the outdoor antenna is replaced by a small loop aerial.

The set illustrated in the article was built for POPULAR RADIO, *and the circuit-diagrams here given have been tested and proved successful in actual operation.*

By LAURENCE M. COCKADAY, R.E.

ANOTHER great step has been taken in the radio art—a step that is destined vastly to extend the use of radio by improving the receiving apparatus in important particulars. Announcement of this important development has only recently been made by Edwin H. Armstrong, the inventor, who gave two impressive demonstrations in New York of what he calls the "super-regenerative circuit." The first demonstration was made before the Institute of Radio Engineers and the second was made a few days later at Columbia University; both meetings were open to the public and both were attended by great numbers of radio enthusiasts. So important is this discovery regarded in scientific circles and so far-reaching is it in its effect upon the development of radio, that detailed information concerning it is of value to radio amateurs and professionals alike.

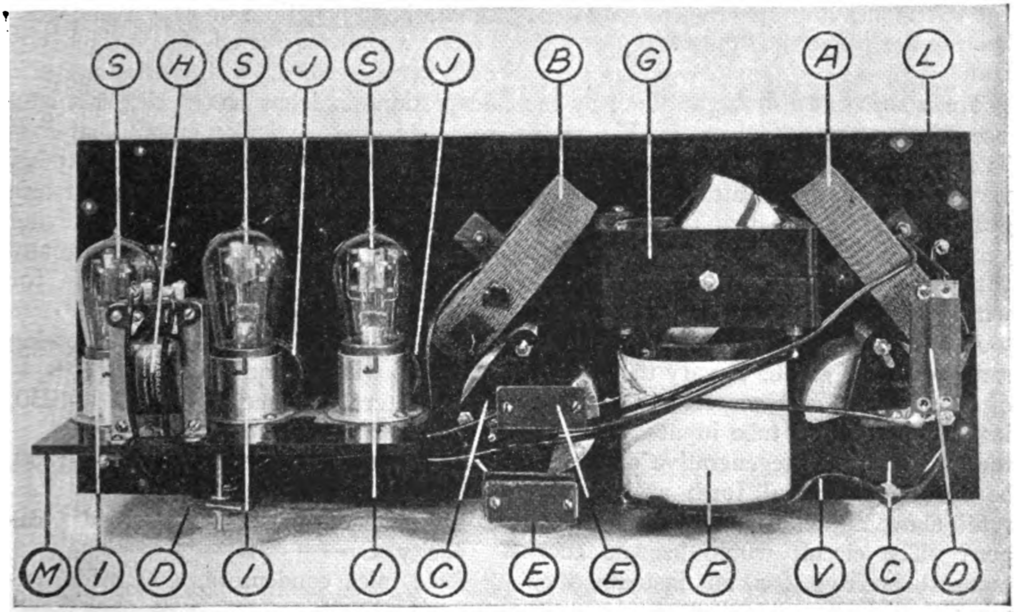
The remarkable feature of the new Armstrong circuit lies in the fact that it permits almost unlimited amplification —but at the same time requires only a small number of tubes. In Armstrong's demonstration he used one, two or three.

Users of Armstrong's ordinary regenerative circuit will remember how, by turning the knob of the dial marked "regeneration," the signal strength of incoming messages could be increased slowly at first and then with a rush as the dial approached the point on the scale where the circuit began to oscillate. If the dial were turned beyond this point the voice signals would become distorted.

Many investigators have wondered if it would be possible to prevent the circuit from self-oscillation by some means, even if the dial should be turned past this point, thus obtaining an unlimited amount of amplification without experiencing trouble from the distortion which would certainly take place were the circuit to produce oscillations. The general opinion among the experts was that this was not possible; Armstrong himself, up to a year ago, would have replied in the negative.

Nevertheless he continued his researches with the vacuum tube, studying the reactions that took place in the tube circuits and learning just what sudden changes in the positive and negative resistances of the circuits would accomplish. Finally he conceived the idea of his new invention.

It is a well-known fact that a tuned circuit will oscillate if the resistance of the circuit is not too great to dampen out the oscillations. Now suppose that we should introduce a certain critical amount of resistance in the vacuum tube input circuit of an ordinary regenerative receiv-



From a diagram made for POPULAR RADIO

HOW TO MOUNT THE INSTRUMENTS

FIGURE 1: *The various items that are required in the assembling of this Armstrong-circuit set are illustrated in this diagram. Note that the coil F and the variometer G are placed in inductive relation to each other. The regeneration in the first tube circuit is controlled by the variometer.*

ing set while it is in a state of oscillation. Under these new conditions the oscillations would suddenly be dampened out and cease.

If this adding of resistance to the circuit could be done periodically (say at a frequency just above the frequency that the human ear could detect), the vacuum tube circuit would become, alternatingly, extremely sensitive and then dead and sluggish.

In other words, the circuit would be "damped" at intervals that occurred at a high rate of speed. During these intervals the circuit would be of increased resistance and the self-oscillation would cease. But between these intervals the circuit would be at an extremely critical stage, as the resistance would be withdrawn and the circuit, while trying to start oscillating, would amplify incoming signals enormously. This would give a series of periods of almost unbelievable amplification which would follow each other so rapidly that they would seem to run into each other; so far as working the telephones and affecting our sense of hearing are concerned, they really do just that.

These results are brought about by the use of the circuit shown in Figure 4. The damping device consists of another vacuum tube which is attached to the regenerative circuit so that the oscillations generated by the second tube effectively vary the damping of the first tube circuit with respect to the regeneration.

Another method for accomplishing the same results would be to vary the amount of regeneration with respect to the damping of the vacuum tube input circuit. If the handle of the regenerative dial could be rotated back and forth at a terrific rate (above audibility), what would happen? The circuit would become enormously sensitive for an instant; then when the knob was brought back in the opposite swing, it would be effectively prevented from self-oscillation. This method would give the same series of periods of increased amplification as the first method, and is accomplished by the use of the circuit shown in Figure 5, in which the second tube is attached to the plate circuit of the first tube by means of the coupling transformer T and the condensers C2 and C3, so that the oscillations generated by the second tube are used to vary the amount of regeneration in the first tube circuit.

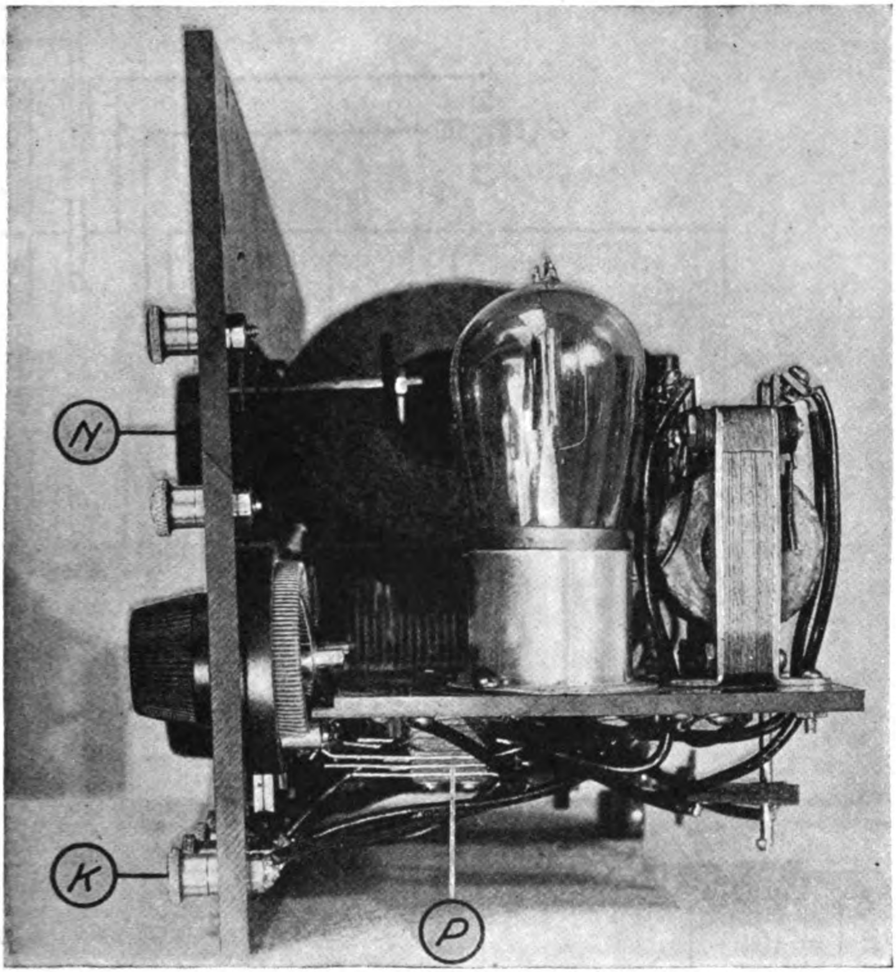
Still a third method may be used for super-regeneration. This is accomplished by varying both the damping of the first circuit, and the amount of regeneration, at the same time, with respect to each other, keeping the proper phase relations. Figure 6 shows such a circuit, where the same tube is used for both regeneration and for generating the oscillations by which the characteristics of both circuits are varied, the second tube being used merely as a detector.

Since Armstrong made his announcement many experimenters have tried to get a receiving set that embodies one of these different methods to work. Some have had great success with it, while others have had little or none.

The writer has tried the various circuits as described, with variations and adaptations and has had such great success with one particular circuit that it is recommended for use by the amateur because of its simplicity of operation and flexibility. It can be used for receiving continuous waves, telephone, music, and (by making slight adjustments) for spark reception.

For building this set, the following materials will be required:

1 duo-lateral or honeycomb coil, L-1250, A.
1 duo-lateral or honeycomb coil, L-1500, B.
2 variable condensers, .001 mfds. capacity, C.
2 fixed mica condensers, .002 mfds. capacity, D.
2 fixed mica condensers, .0005 mfds. capacity, E.
1 insulating tube, 4 inches long, 3 inches in diameter, wound with 60 turns of

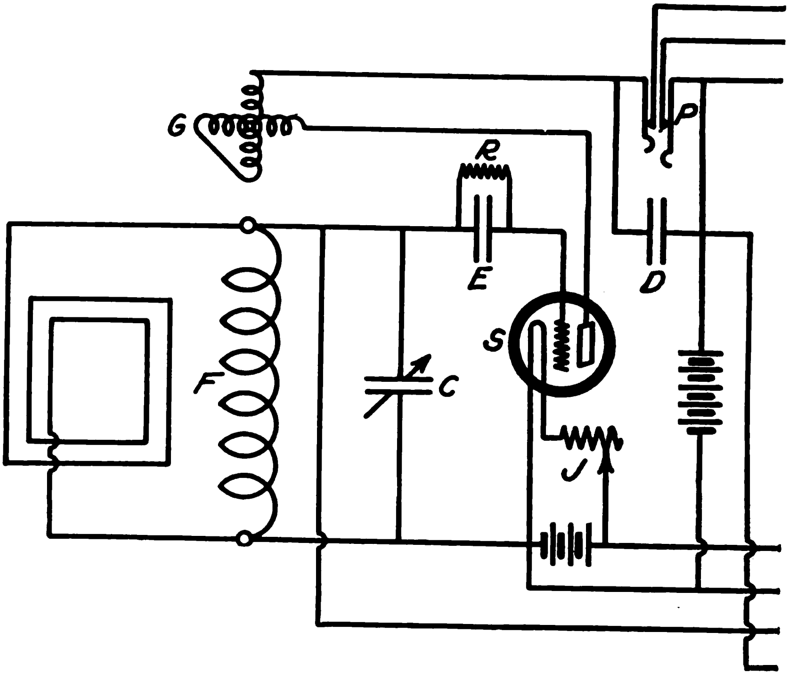


From a photograph made for POPULAR RADIO

A SIDE VIEW OF THE SET

This diagram shows how the shelf for supporting the tubes and the amplifying transformer is mounted on the jacks P. (These jacks are fastened to the panel L, shown in Figure 1.) The filament rheostats are fastened to the rear of the panel with the small controlling knobs protruding through the panel. Compare this view with that on page 19.

No. 18 SCC copper wire, F.
1 moulded variometer, G.
1 amplifying transformer, H.
3 tube sockets, I.
3 filament rheostats, J.
10 binding posts, K.
1 insulating panel, 8 inches by 20 inches by ¼ inch, L.
1 insulating panel of suitable size for mounting sockets and the amplifying transformer, M.
3 large knobs and dials, N.
1 cabinet, outside dimensions 8 inches by 20 inches by 6½ inches, with a door at right top, 4 inches by 8 inches, for inserting tubes, O.
2 automatic lighting jacks, one double circuit and one single circuit, P.
1 duo-lateral or honeycomb choke coil, L-200, Q.
1 1-megohm grid leak, R.
3 radiotron UV-201 vacuum tubes, S.
Miscellaneous screws and bolts (brass), T.



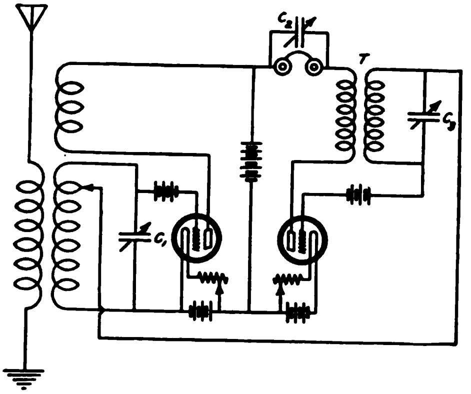


FIGURE 4

This diagram illustrates the method of obtaining super-regeneration by varying the damping of the first tube circuit with respect to regeneration. The set described in this article uses an adaptation of this method.

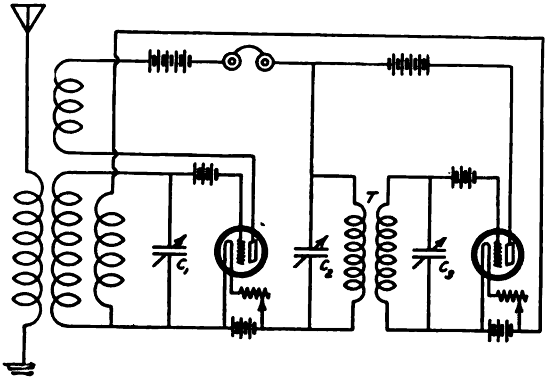


FIGURE 5

This circuit diagram shows how super-regeneration may be obtained in still another way—by varying the amount of regeneration with respect to the damping of the input circuit of the first tube.

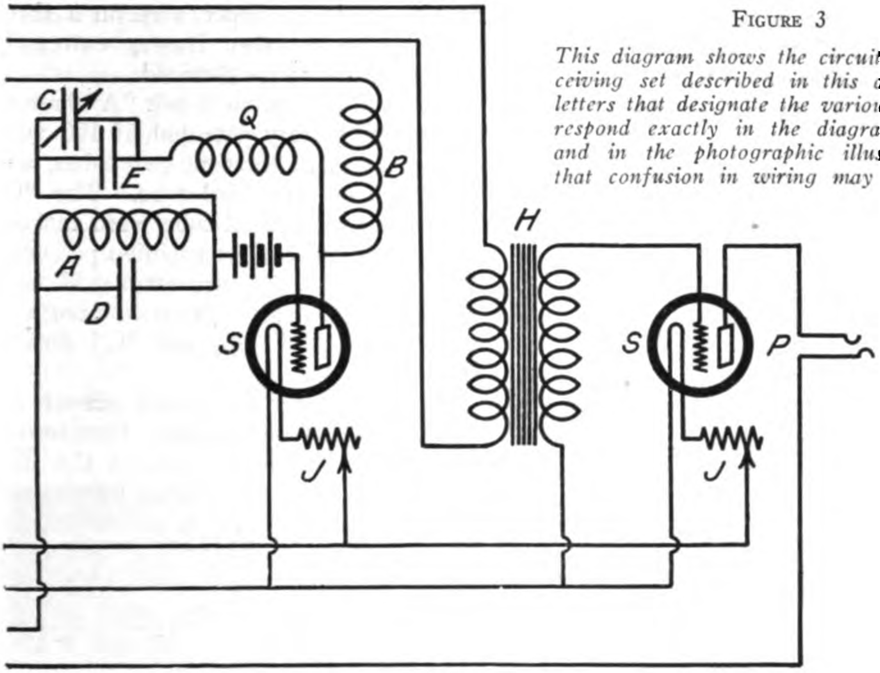


FIGURE 3

This diagram shows the circuit for the receiving set described in this article. The letters that designate the various parts correspond exactly in the diagram, the text and in the photographic illustrations, so that confusion in wiring may be avoided.

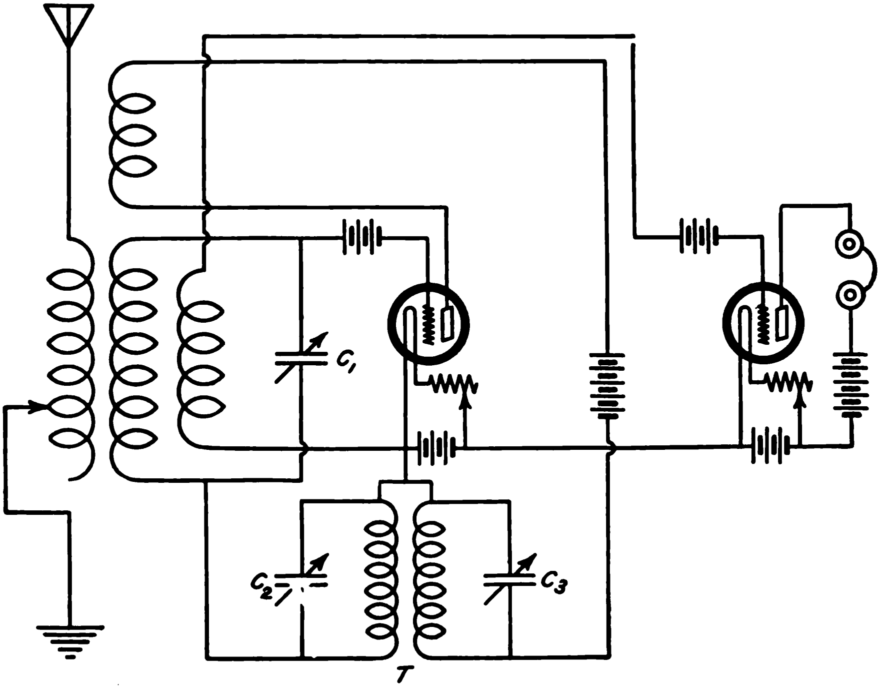


FIGURE 6

How super-regeneration may be obtained by varying both the damping and the regeneration with respect to each other, keeping the proper phase relations.

Some connecting wire (bare copper), U.
Varnished cambric tubing for insulating
 the connecting wire, V.

The panel is laid out as shown in the illustration on page 18, in which the three small knobs and pointers at the right are the filament rheostat controls, with the two telephone jacks mounted directly beneath. The two large knobs at the left bottom are connected to the two variable condensers and the large upper knob is fastened to the variometer.

The method of mounting the various instruments on the back of the panel is shown clearly in Figure 1.

The method used for mounting the tube shelf on the telephone jacks is indicated in Figure 2.

After the instruments have been mounted, they should be connected up according to the diagram shown in Figure 3. All joints should be soldered. Connecting wires should not run parallel for any great distances.

The parts on the diagrams and the photographs bear the same letters as the list of parts in the text so the amateur should have no trouble in assembling this set.

The duo-lateral choke coil cannot be seen in the illustration, but it is mounted flat against the panel in the rear of the coil, F.

The two binding posts at the left of the panel in the first illustration are for connection to the loop antenna. Starting at the left, the row of binding posts shown in the illustration should be connected as follows: first, negative "A" battery; second, positive "A" battery and negative "B" battery; third, "B" battery positive of the first two tubes; fourth, "B" battery, positive of the third tube; fifth, positive "C" battery for second tube grid; sixth, negative "C" battery for second tube grid. The two binding posts arranged vertically at the right can be used for connecting to a loud speaker.

When the set is completed and hooked up to a suitable loop antenna, which can easily be made by winding on 12 turns of No. 18 SCC copper wire on a three foot square wooden frame, extremely good results may be obtained.

The writer used an 8-volt "A" battery and a "B" battery potential of 100 volts on the plates of the first two tubes, and 150 volts on the third tube. The "C" battery on the second tube, used to keep the grid at the correct negative potential, was 3 volts. An ordinary grid condenser and grid leak was used here with fair results, although the "C" battery was better.

The condenser connected across the primary of the amplifying transformer was found sufficient to bipass the high frequency current generated by the second tube and prevent it from inducing a strong current in the grid circuit of the amplifier tube, thus "knocking" the amplifier tube. No other form of filter was found necessary, although a good filter probably would help here.

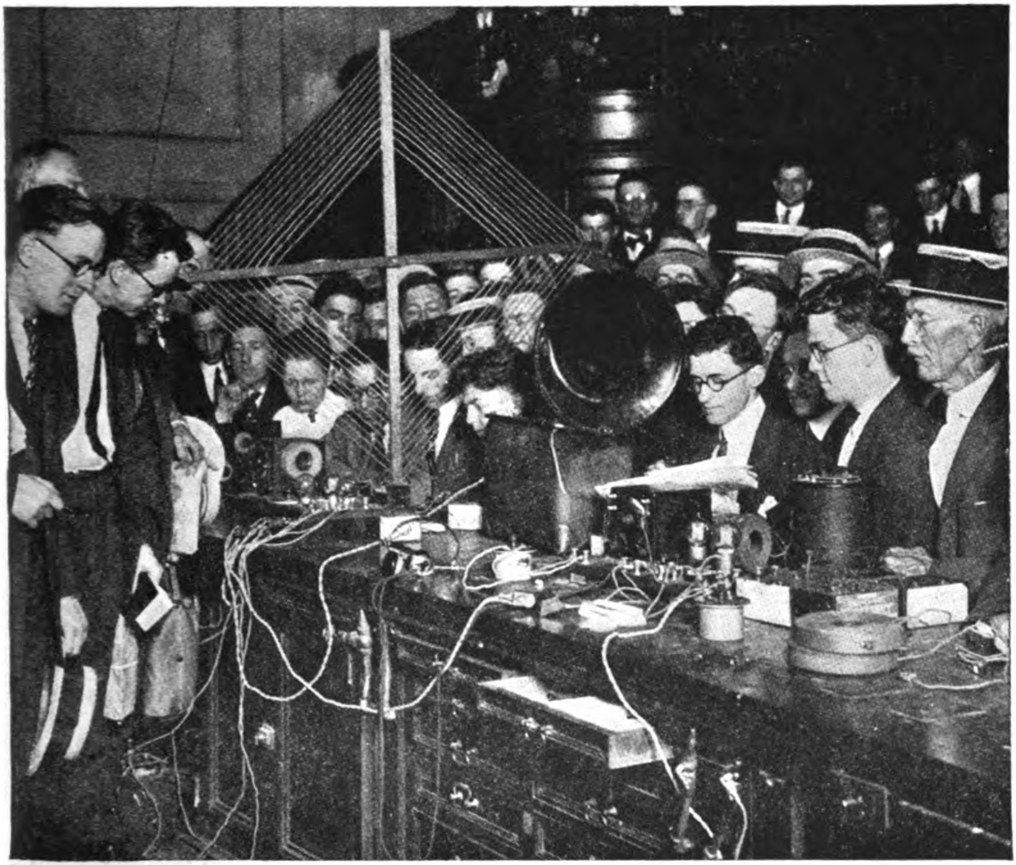
The object of this description of the set is not so much to show the amateur all the structural details of a set that employs this circuit, but to give a general idea of a simple way to build it so that it will work, if the main points are carried out to completion.

The easiest way to find out how to tune the set is to turn up the filaments of the tubes rather high, and then set the tuning condenser located at the lower left hand corner of the panel at zero. The next move is to turn the other lower condenser to a near-maximum setting. Then the upper dial which is affixed to the variometer should be turned in the same manner as the ordinary tickler adjustment until a loud squawk is heard. Then turn down the filament of the second tube slightly until the squawk increases in intensity. The squawk is then tuned out by adjusting with the variometer and for each given setting of the wavelength tuning condenser, there is a setting on the variometer at which static and signals will come in loudly. When a signal is finally tuned in it may be slightly distorted or mushy at first, but it can be cleared up by careful adjustment of the two lower knobs and by slightly varying the filament adjustments of the three tubes.

In a few hours of practice the amateur can master the method of tuning this new set by learning what each particular sound heard in the receivers means in regard to adjustment.

After operating such a set as described for three hours the writer was able to tune in with ease on a loop any of the Eastern broadcasting stations; some of these stations were clearly heard throughout the room even when there was not any loop connected to the receiving set at all.

During the first night of operation of this set, in fifteen consecutive minutes, the following C. W. amateur stations were picked up on a round loop one foot in diameter; the set was installed in the writer's laboratory in New York, with a steel elevated structure almost directly overhead: 1CXB; 1BDU; 3OT; 3ZO; 4DC; 4GL; 4GV. By turning the loop east and west the experimenter picked up 8BDT; 8BPA; 8UE; 9DZY; 8AQW and Canadian 9AL, stations as far west as Kansas, as far south as Georgia and as far north as Canada.



Kadel & Herbert

THIS SET AMPLIFIES FROM 100,000 TO 1,000,000 TIMES

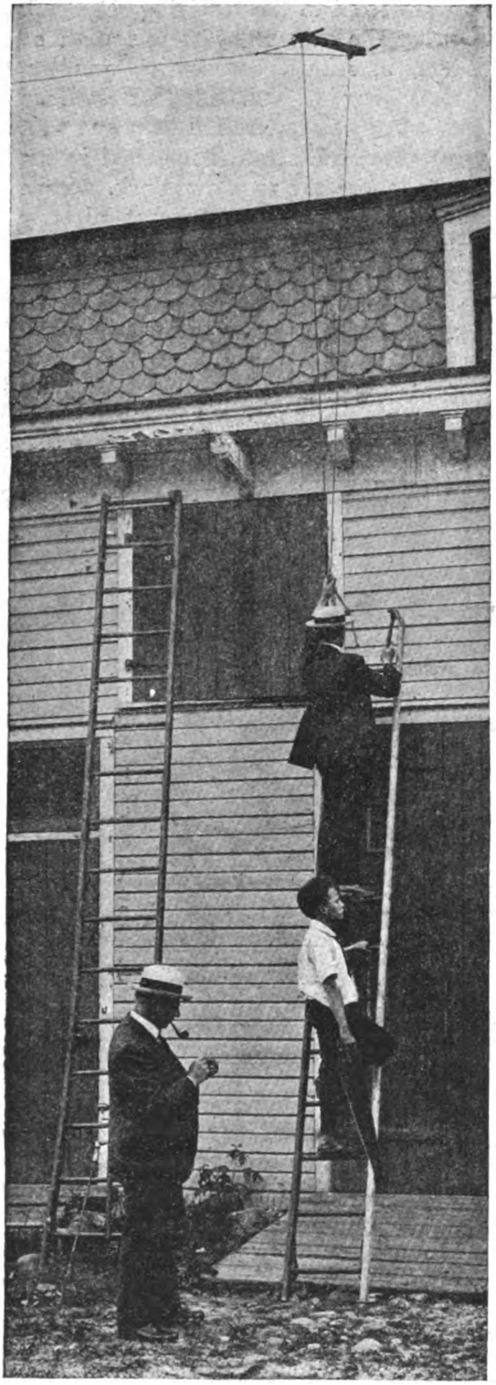
When E. H. Armstrong demonstrated to the public his remarkable super-regenerative receiver at Columbia University he remarked: "The super-heterodyne circuit is still the Rolls-Royce method of getting practically unlimited amplification. But there are some people who prefer to use Fords. This super-regenerative circuit is the Ford method of amplification." This picture shows some of the radio fans, young and old, who grouped about the set—following the demonstration of its capacities.

I Install My Receiving Set

This Article Is Written for the Purpose of Giving Sound and Practical Help to the Layman Who Puts Up His Own Radio Apparatus With No More Experience than that Possessed by the Author——

ELLIS PARKER BUTLER

Author of "Pigs Is Pigs"



From a photograph made for POPULAR RADIO

I STRING UP MY ANTENNA

Some people use a screw-driver and some use a monkey-wrench, but I have found that a boden works better than either.

FOR installing a radio outfit some people use a screw-driver and some use a monkey-wrench, but I have found that an ordinary boden works quicker and does a better job. To install my radio outfit I used one large boden and one small one, and the results were perfect. For installing radios I shall hereafter use nothing else.

It was like this: Someone called me up on the telephone and asked me if I had a radio outfit, and I said "No." Then he asked me if I didn't want to buy one, and I said "No!" Then he asked me why, and I said I had a player-piano and a phonograph and a pair of twins learning to play the piano and no time to bother with a radio anyway. I told him that I wouldn't have anything to do with radio. I said that three or four years from now, when my small son was big enough to make and install one, he might have one if he wished but that I did not want one and that was all there was about it.

When my radio outfit was delivered at my house three or four days later I found it consisted of one flat cardboard box full of things and one oblong box full of things and some other things. In each box was a paper sheet of "Directions," with a picture of a house and a barn with a wire stretched between them. The picture was evidently taken just after the Mohawk Indians had made an attack on the settlement, for everything was stuck full of red arrows. Some of the arrows were marked "Screw Eye," that probably being the name of the Indian that had shot the arrow. Personally I think Screw Eye is as good a name for an Indian as Rain-In-The-Face or Sitting Bull, but some of the names were peculiar. I can imagine some romantic Indian mother naming her child "Insulating-Entrance-Bushing" but, if I was an Indian mother and had forty children I don't believe I would think of naming one of them "No. 14 Copperweld Antenna Wire." And yet one of the arrows was marked that. It was also marked "75 to 150 feet long, 25 to 50 feet high." If this was the size of the Indian that shot that arrow he must have been a giant. He was probably the Chief.

At exactly 10:45 Sunday morning I spread out the direction sheets and counted the things in the boxes. This is always a safe way to begin. It looks efficient. Then I counted the things mentioned on the sheet of directions and found that they agreed in number and variety with the things in the boxes. There were thirty-three things, thirty-one of which I did not know what to do with. The other two were screw eyes. A man with a mechanical turn of mind such as mine is not often fooled by a screw eye. As soon as he sees it he knows it is meant to screw into something. The only question was what I had better screw the screw eyes into.

The man who brought my radio outfit to my house—when I was not at home—had taken a look around and he had told my father to tell me that he thought I had better string the antenna wire from the roof of the house to the tree out back there. This was all right except that the tree was beyond my fence and in Mr. Bourguignon's back lot. It was not my tree; it was Mr. Bourguignon's tree. Of course I might have bought the tree and had it moved into my yard, but no one would have moved it on Sunday, even if Mr. Bourguignon wanted to sell it, and I wanted to get through with the job that day. The other alternative was to leave the tree where it was—it was a big tree—and buy Mr. Bourguignon's property, but his property has a house and six garages (five cement ones and one frame) and a chicken coop and a tennis court and other things on it and it hardly seemed worth while to go to the expense of buying it.

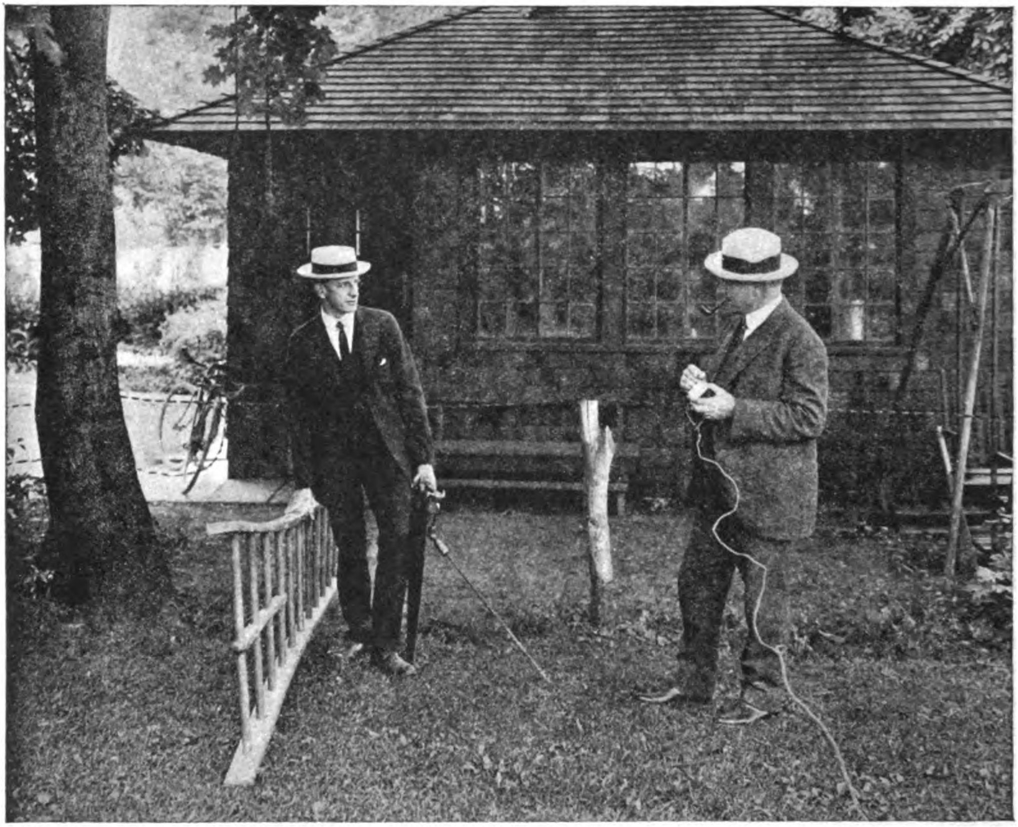
I might have gone to Mr. Bourguignon and have asked him to loan me one cubic inch of the tree to screw the screw eye into, but my wife has a garden and the Bourguignons have chickens. The Bourguignons keep their chickens cooped up and out of our garden in the nicest way possible, but one can never tell. A cyclone might blow down their chicken coop and let the chickens into my wife's garden and a chicken might eat a petunia. Then, if in hot anger I murdered the chicken, Mr. Bourguignon might climb the tree and chop down my antenna just when Galli Curci was going to sing an aria or something, and that would be a catastrophe.

You can see by this what tremendous difficulties we radio engineers have to contend with. So I put the large flat cardboard box on the grass at the corner of my house and hung the loop of antenna wire over my arm and lighted my pipe and read Article 1, Section 1, of the Constitution and By-Laws, which said, "Select location for antenna as free as possible from trees, buildings, towers, etc."

This was a stumper! The only two places I knew of that were as free as possible from trees were the Sahara Desert and the Arizona Desert, and that was not where I was. It was not where I wanted to string the antenna. I wanted to string it in my own back yard.

The directions then said that "except at ends, antenna wire should not come closer than ten feet to any of these objects." Then "Wire may be supported from buildings, poles, or trees." Direction 2 said "Uncoil Copperweld Antenna Wire and lay along ground between supports."

This was something like business! This



From a photograph made for POPULAR RADIO

I AM CONFRONTED WITH A TECHNICAL PROBLEM

It was evident to me that the 70 feet of bedspring was not going to lay itself down flat and neat and then boost itself into the air like a properly trained antenna.

was something to do. I began at once.

"Here!" I told my young son; "Take the end of this wire and walk down to the fence with it and hook it onto the fence."

I said this calmly and with seeming indifference, but, as a fact, I was deeply agitated. I had meant to come out of the house, rig up the antenna, put it through a window, hook it onto the doojah that you hear through, and then sit down and hear the morning sermon. That was allowing fifteen minutes for the job, and to a man of my capabilities it should have been sufficient. It is all right for a ten-year-old boy to take an hour to two to build and install a radio outfit, but a man—and a busy man—cannot afford to waste time.

Unfortunately I saw at once that if the "No. 14 Copperweld Antenna Wire" was to be "25 to 50 feet high" I would need a ladder. I can reach eight feet high, and if I stand on a chair I can reach eleven feet high, but I cannot reach fifty feet high. And I had no ladder. In stringing an antenna wire between a house and a barn properly a ladder is almost a necessity. There is only one thing that can take its place; this is a boden.

My son took the end of the wire down to the fence and as the wire unrolled off my arm it took the form of a spiral. It was like a seventy-foot bedspring, and I had a lot of wire left on my arm. It was evident to me right then that the wire was not going to lay itself down on the ground as flat and neat as a stretched string and then boost itself up into the air where I wanted it, and behave like a properly trained antenna, with soldered connections and everything.

At that moment a voice behind me said:

"Hello! Putting up your radio?"

I turned and saw the very boden I had been needing. Perhaps it is better to spell it with a big B, like this—Boden.

"Yes," I said to Boden, and he came up to the fence.

"I am spending this Sunday collecting money for the Flushing Hospital," he said, and added: "You can't unroll a coil of wire that way, as if it were a rope; it twists and kinks if you do. I'll show you how to unroll a coil of wire."

So the Boden—perhaps it is better to say it with a Mister, like this—Mr. Boden—came over into my yard and unrolled the coil of wire. It reached from where I was to the fence and back, and as Mr. Boden wanted to show me how to straighten a wire that had spiralled itself into kinks I let him show me. I held the end of the wire while he showed me.

I was now making good progress and was well pleased. Mr. Boden came and took the end of the wire out of my hand and placed it on the lawn. The difficult part of my work was now to be done: the brain work. That is my specialty. I felt at home. I spread out the sheet of directions and picked up a screw eye. Then I put the screw eye back in the box. I am never afraid of good hard work.

"The picture on these directions," I said, "shows a single antenna wire, and the directions say 75 to 150 feet. As it is only seventy feet from my house to my barn I guess seventy feet will do."

Having settled that once and for all I was well pleased. I like to get things settled definitely. I detest indecision. Once I had decided on a single wire seventy feet long the rest was easy. I lit my pipe while Mr. Boden decided that my aerial was not to be a single wire but a double wire hung with spreaders and insulators. I lit another match and remarked that I did not have any spreaders and that I had only two insulators. Mr. Boden went over to his house and got two hickory spreaders that happened to be nicely wired and to have holes in them where holes were needed, and also two more insulators. I then lit another match—I smoke damp tobacco—and Mr. Boden said my aerial was going to be fastened to my kitchen chimney with a rope and to the barn with another rope. I told him I had a rope, and he seemed pleased. One's labor is made much more pleasant when installing a radio outfit if the Boden used is the sort that seems pleasant now and then.

Having proceeded this far I looked at the barn and said I would probably need a ladder, so Mr. Boden went home and got a large ladder that was in two sections. He brought it into my yard and put the two sections together and stood them up against the barn.

I was now ready to get down to solid work. I took out a fair-to-middling looking safety match and struck it while Mr. Boden strung the antenna wire through the spreaders and made them fast there, wiring the insulators where they should be. As there was a slight breeze the match went out, and I lit another. This assistance greatly inspired Mr. Boden and he sent a junior Boden home for his soldering outfit while he uncoiled the 35 feet of No. 14 B & S gauge insulated copper lead-in wire and twisted it neatly to the antenna wire at the proper place.

Having allowed Mr. Boden to solder the joints neatly and permanently I was now ready to begin work in real earnest. I took out my watch—it was given to me by the citizens of Flushing because of the tireless manner in which I do any job I undertake—and while I wound it Mr. Boden got a large length of stout wood out of my barn and, climbing the ladder, nailed it upright against one of the dormer windows of the barn. I then permitted him to come down, because he wanted to go home to get his saw, and when he had brought the saw and several pieces of board into my yard, I showed him a good place to put the boards while he sawed them into braces. Then he went up the ladder and nailed the braces in exactly the place I should have selected myself.

Luckily for us all, Mr. Boden, when he went up the ladder, had taken one end of a rope with him as well as the two screw eyes. He now screwed the two screw eyes into the upright length of stout wood and ran the rope through the eyes of the screw eyes. With my usual indefatigability I tied the other end of the rope to the antenna business so that he could pull it up and fasten it snugly in place. You can imagine my pride when I saw that glistening copper wire high above my head ready to receive the mysterious electric waves that are the marvel of the twentieth century, and knew that I had done the whole job myself without assistance of any kind.

"Boden," I said, "I have done a good job."

"I have to go home for dinner now," he replied.

"In that case," I said, "it is time for me to rest and refresh myself with a little food. I believe a laboring man deserves his full hour at noon."

After dinner I looked around for the full sized Boden but he was not to be seen. I was a little hurt to be thus deserted just when I was ready to begin the really intellectual part of my job—hooking up the lightning arrester and connecting the batteries and the Type NF Style 319564 Receiver and attaching the telephone earpiece doodads. Fortunately I am a man of resourcefulness. To do all this delicate work I had nothing but a pocket knife

From a photograph made for POPULAR RADIO

I LET MY NEIGHBOR BORE THE HOLE

I had intended boring the hole myself, so that I could say that I had installed my radio outfit myself and without any help whatever. But Boden went for the brace and bit so cheerfully that I thought I would reward him.

and a small sized Boden. For a reason which I shall mention a little later I was unable to insert the "insulating entrance bushing" through the side of the house to poke the wire through, so—temporarily—I opened a window and put the wire through the opening thus created. As the window was large I had little difficulty in putting the wire through the opening. I then laid the second sheet of directions on an almost-mahogany table while the small sized Boden attached twelve or fourteen wire ends to different parts of the lightning arrester and receiver. When I had thus hooked on the various wires my real work began.

In installing a radio outfit it is necessary to have what we technical experts call a "ground wire." This is a wire that connects the aerial with the earth. The idea seems to be that when the radio wave leaves its distant home and roosts on your antenna it immediately becomes homesick and wants to get back home. If you give it a "ground wire" it slides down it and goes right home by subway, giving your receiver a kick as it goes. This is what puts life into your receiver, but if you do not give the wave a "ground wire" it roosts on the antenna and dies there and falls off and never squawks again. This explanation may be too technical for some of my readers but those who have made a life study of radio will understand it. It therefore became necessary for me to save the lives of countless radio waves. I did so. I took the coil of wire—one end of which the junior Boden had fastened to the lightning arrester—and threw it out of the window. I then went outdoors and wrapped one end of this wire around the spigot I use to fill the watering can when I want to fill the bird bath.

It was now 3:45 P. M. and I was quite exhausted. I went into the house and found that the junior Boden had attached the ear things and had pushed the glass bulb into the place that was meant for it and done something to several dials. At exactly 3.46 P. M. I put the ear piece to my ear and broke right into the middle of a Mother's Day sermon that was coming through the air from Newark, New Jersey.

This shows what a man can do when he is not afraid of work and makes up his mind to do a thing, no matter how difficult or laborious it may be. Nothing dismays such a man. Nothing can conquer him. He decides to do a thing and he does it.

And I am not a radio installer by profession either; I am an author. The fact that I am an author makes the work I did in installing my radio outfit all the more wonderful, but it led to the second and final triumphant day of work.

The room in which I had temporarily installed the radio receiver is the room in which I do my authoring and I soon found that having the receiver one foot and three inches from my desk cramped my style. It is almost impossible for an author to turn out work like Thackeray's and Shakespeare's while he is listening to WJZ give the weather forecast, the final baseball score, an orchestral concert, a lecture on Oral Hygiene and a talk on "The Hopeful Side of the Cancer Problem." It is almost annoying to write with ink when two twins, three minimum sized boys, a wife or two and a few neighbors are sitting on the desk, the inkstand and sheet 6 of the manuscript, listening to radio. So I decided to move radio to another room and install him permanently there according to a column and a half of new fire and lightning regulations.

No sooner said than done! Unhooking all wires I threw them out of the window. And now came the strenuous part of the work. A week had passed by and again it was Sunday morning. I went out in my yard and waved lengths of wire in the sun but no Boden came to the fence. I leaned against a fence post and studied the sheet of directions but no Boden appeared. I feared some other radio enthusiast was using my Boden, but I discovered this was not so; he had gone to church.

I had purchased thirty-five more feet of lightning proof wire and a lot of porcelain thingumbobs. The thingumbobs I

From a photograph made for POPULAR RADIO

I PUT THE FINAL TOUCHES ON THE INSTALLATION

I found that the Junior Boden had attached the ear things and had pushed the glass bulb into the place that was meant for it and done something to several dials.

screwed to the side of my house and on them I strung the wire. This brought me to the window casing in which I wished to insert the "insulating entrance bushing" without which no modern home is complete. As it looked as if it was going to be impossible to push a baked clay "insulating entrance bushing" through a hard pine window casing I went inside the house. To do this I had to go half around the house, up the back-porch stairs, through the back entry, through the kitchen, through the butler's pantry, through the dining room and into the "little room." Having done this I looked at the floor. It was a hard floor. I must bore a hole through the hard floor into the cellar and run the "ground wire" down to a water pipe there. I went out of the "little room," through the dining room, through the butler's pantry, through the kitchen, through the entry, down the back-porch steps, across the yard, into the barn and looked at the tools there. The only tool I saw that would bore a hole was a gimlet, so I took the gimlet and went out of the barn and across the yard and up the steps and through the entry and through the kitchen and through the butler's pantry and through the dining room and into the "little room."

I next decided to bore the hole and bored it. As the hole was not big enough to admit the wire I went out of the "little room," through the dining room—well, anyhow, I went to the barn and got a brass rod that I found there, and a hammer, and went back and hammered the brass rod down the gimlet hole. Immediately the far end of the brass rod hit something as solid as the rock of Gibraltar—solider, even. It was the foundation of the house. Then I tried to pull the brass rod out of the hole and it would not come. It was stuck there.

I went out to the barn and got a puller and went back to the house and pulled the brass rod out of the gimlet hole. I chose a spot three inches from the first hole and bored another gimlet hole in the floor. This time the brass rod, when driven into the gimlet hole, struck the foundation of the house. It was the same foundation of the same house.

When I had pulled the brass rod out of the gimlet hole I went down cellar and looked at the foundation and came upstairs and bored another hole. I drove the brass rod into this hole and hit something medium hard. I went down cellar and looked for the end of the rod, but I could not see it, and I went upstairs and looked at the rod and downstairs and looked for it again and upstairs and measured from the window edge to the rod and downstairs and discovered that the cellar window was not as wide as the room window. So I went upstairs and outdoors and measured from the edge of the cellar window, and went downstairs and measured from the edge of the cellar window there, and discovered that the gimlet hole was undoubtedly immediately above the washroom partition. So I went upstairs and bored another gimlet hole in the floor.

This time the brass rod, when hammered into the gimlet hole, went through and took a part of the cellar's plaster ceiling with it. I pulled the rod out of the hole and poked a quarter of a mile of insulated wire down the hole and went down cellar to sand-paper the water pipe and attach the patent "ground clamp, Style 319501." There was no wire! A quarter of a mile of wire had gone down the gimlet hole and mysteriously disappeared!

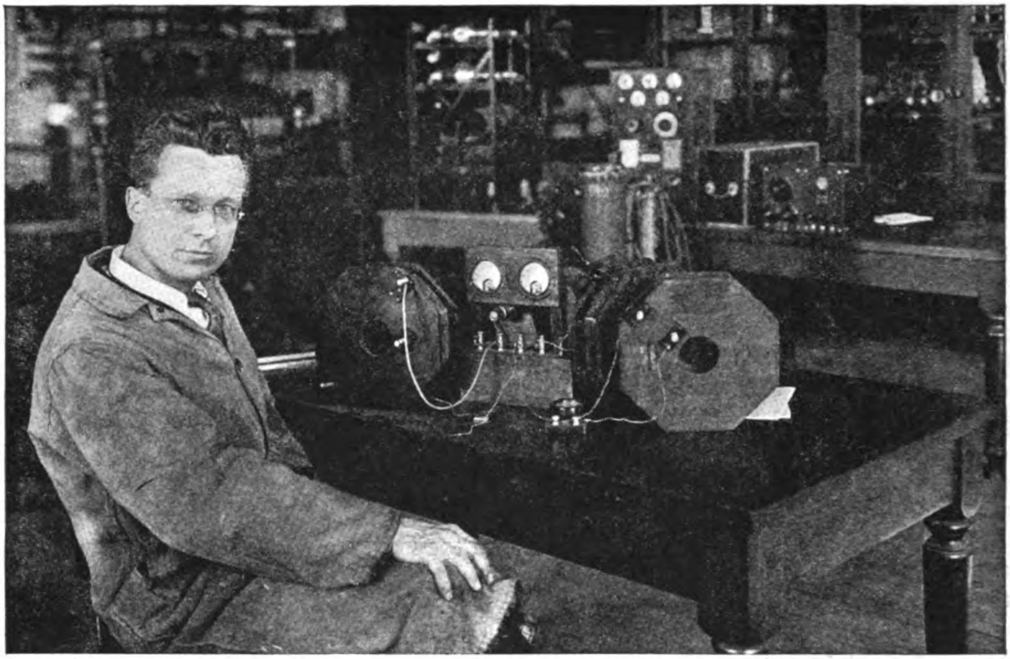
Later I found it between the cellar's plaster ceiling and the floor above, and eventually I coaxed it—by speaking to it gently—to go down into the cellar.

I was now all ready to perform the final operation of the installation of the radio outfit, and while I waited for the sermon in the Congregational Church to conclude I attached the lightning arrester to the wall. By this time I heard a noise like a Boden next door and I wandered over in that direction and casually remarked that the directions said a five-eighths bit was a good size to use in boring a hole for the "insulating entrance bushing." My priceless Boden immediately went down into his cellar and returned at once with a brace and a bit about a yard and a half long.

I had intended boring the hole myself, so that I could say that I had installed my radio outfit myself and without any help whatever, but the Boden went for the brace and bit so cheerfully and returned so promptly that I thought I would reward him. I let him bore the hole.

Should Uncle Sam Levy a Tax on Radio Receiving Sets?

Broadcasting is already a public utility. Some way must be found to make it a profitable enterprise in itself. Foreign governments, which subsidize operas and theatres, may levy a tax on radio apparatus and contribute the proceeds to government-controlled broadcasting stations. Will that happen in the United States? Read Waldemar Kaempffert's thoughtful article on this problem—one of the most vital problems that confront the radio fan—in a near issue of POPULAR RADIO



From a photograph made for POPULAR RADIO

A MASTER OF ELECTRICAL THEORY

Few scientists have done more useful experimental work with vacuum tubes than Prof. Morecroft of Columbia University, and none has written more clearly and authoritatively on the subject. This article is one of a series which he is writing especially for POPULAR RADIO.

How *the* Vacuum Tube Works

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 5

What the "Triode" Is, How It Is Made and What Takes Place Inside of It—Told in Language that Every Radio Fan Can Understand

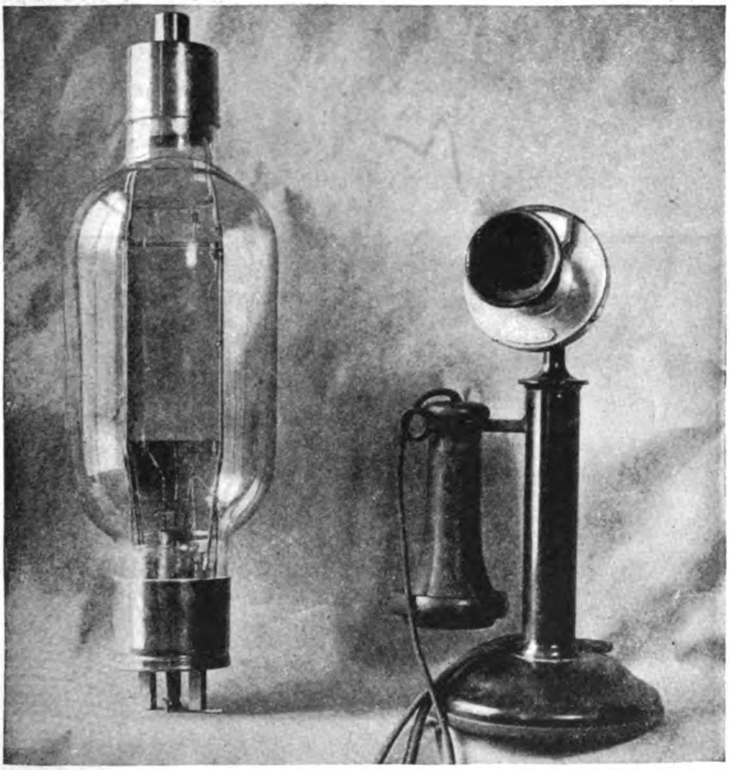
By PROF. J. H. MORECROFT

THE vacuum tube is a device which, by a peculiar action, can take continuous (or direct) current power from a battery or generator and transform part of it into alternating current power. The frequency of the power generated by the oscillating tube is determined entirely by the electrical constants of the circuit; the amount of power it is possible to generate is determined primarily by the size of the filament and plates of the tube, and secondarily by the adjustment of the circuits.

To any one at all familiar with the ordinary laws of the electrical circuit it will seem strange that a source of continuous power supply can, by means of such a device, be changed to an alternating current power supply. The ordinary laws of electrical circuits seem to prohibit just such an occurrence. If we have a generator that gives a continuous voltage and we connect a circuit of any kind to the terminals of this generator we expect to get a flow of continuous current, and practically always we do so. How then is it that the vacuum tube, or triode, as it is gradually being re-named, can transform such a continuous energy flow into an alternating energy flow?

It is first to be pointed out that there are many occurrences in our everyday life where just such phenomena are taking place, yet we scarcely notice them—occurrences in which a simple, straightforward push or pull makes something vibrate backwards and forwards. In fact, it seems likely that the present popular study of radio, including such things as the triode, will react to make us observe more closely many of the ordinary events that take place around us, which we do not understand and which have many points of similarity with radio. The oscillating triode certainly has a place in this category; an attempt to understand its action will surely make us pay closer attention to many events taking place around us which we have never questioned, although we have understood them no better than we understand the triode.

Everyone who has studied physics in high school knows that sound is a to-and-fro motion in the air, that it is a vibratory action in which energy flows past the ears at a non-uniform rate; the flow of energy goes from a maximum to zero with a frequency depending upon the musical pitch of the note. Thus the sound from a violin string, giving the middle C, is really caused by a compression and rarifaction wave in the air which sends energy past our ears in the form of "pulses" at a regular rate of 256 a second. The question should occur to anyone who hears such a sound: how can the man's arm, which is evidently exerting a uniform pull on the violin bow, send off energy at the rate of 256 pulses a second? Certainly the man's muscles are



Paul Thompson

A GIANT VACUUM TUBE, AS COMPARED IN SIZE TO A TELEPHONE INSTRUMENT

Tubes of this size (½ kilowatt) are used for transmitting only. Of the various names applied to such tubes, ranging from "radio bottle" and "Aladdin's lamp" to audion, the term "triode" is coming into general use among scientists.

not causing that phenomenon directly.

The answer to this question, although the phenomenon is a common one, is not simple; it can probably be accurately given by no one who reads this article. The question has probably not even occurred to any one of them, yet we frequently hear nowadays the question: "What makes a triode oscillate?" It is a case of the unusual; the violin string is so simple that every one thinks he knows how it works. But the vacuum tube seems much more complicated in its action. As a matter of fact it is easier to get an exact solution of the action of the triode than of the violin string.

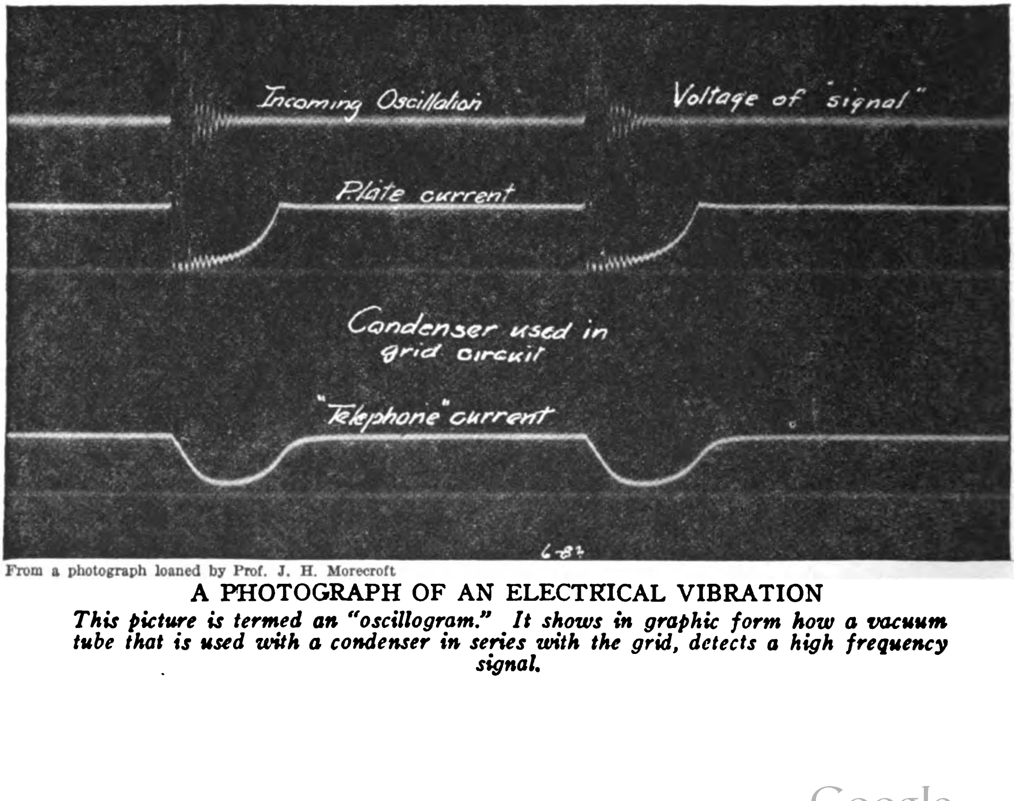
What makes the brakes of a train or automobile give off such a shrill squeal when they are suddenly applied? Does the driver actually vibrate the brake shoe thousands of times a second? Evidently not. What makes the balance wheel of a watch continually oscillate back and forth when the main spring is evidently trying always to push it in the same direction? What makes the steam rush out of a whistle in pulses, giving off high-pitched musical notes when it could apparently flow through the hole through which it is escaping more easily if it came out uniformly—in which case no sound would be given off at all?

Will a toy balloon, towed behind an automobile, proceed uniformly through the air or will it vibrate sideways, even though the towing string is exerting a uniform forward pull? Why does a flag flutter in the breeze?

These cases could be multiplied without number; it seems in many instances that Nature would rather do things in an oscillatory fashion than in a straightforward fashion.

We should not be surprised therefore, in view of the actions just outlined, if the electrons in the triode, on their way from the filament over to the plate, may be made by certain circuit connections to proceed at a variable periodic rate rather than flow uniformly as the continuous current generator or battery in the plate circuit tends to make them do.

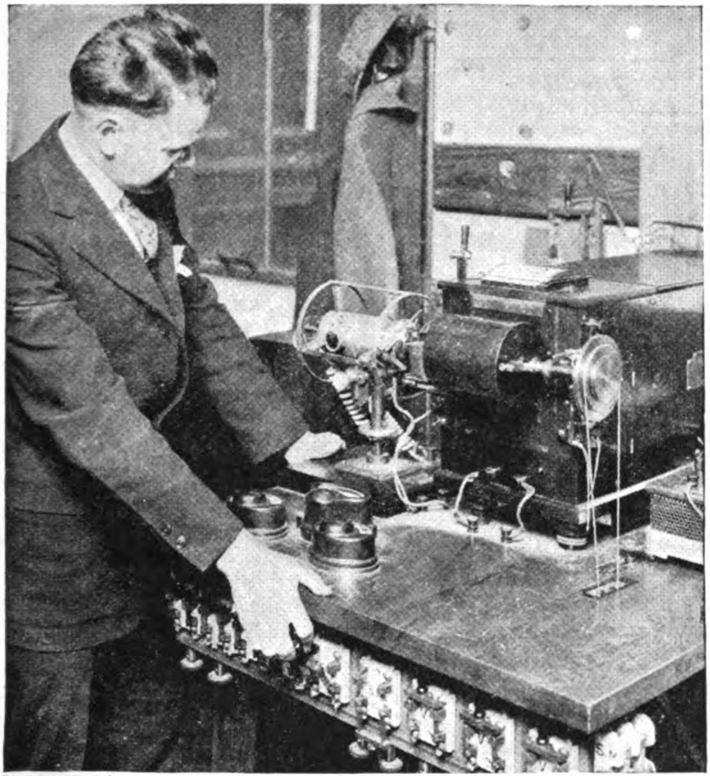
The elements of an oscillating tube circuit are as shown in Figure 1. The plate



From a photograph loaned by Prof. J. H. Morecroft

A PHOTOGRAPH OF AN ELECTRICAL VIBRATION

This picture is termed an "oscillogram." It shows in graphic form how a vacuum tube that is used with a condenser in series with the grid, detects a high frequency signal.



General Electric

THE OSCILLOGRAPH—A MACHINE THAT PHOTOGRAPHS ELECTRIC CURRENT

The film end of an oscillograph box, showing the arc lamp in the spring tube at the left and control switches, vibrators, electric shutters and field magnets. The kind of picture that such a device produces is shown on the opposite page.

circuit generator with its associated choke coil delivers a continuous flow of energy; this energy coming to the tube may be partly used up in the tube and partly flow on to the output circuit, which is the place where the high frequency power oscillations are started. The oscillating circuit may be made to act on the tube, so that the energy is supplied to the circuit in pulses, thus serving to keep it continually in oscillation. This action is much the same as in the escapement of a watch, which lets energy flow into the balance wheel in pulses—the pulses being so timed as to maintain the oscillatory motion of the wheel.

The period, or frequency of oscillation of the balance wheel, is fixed by the effective mass of the wheel and the size of spring used; shortening the spring will increase the frequency and lengthening the spring will lower the frequency. This is what is accomplished by the "faster" and "slower" adjustment of your watch.

As the electrical constants of the oscillating circuit determine the frequency of the alternating current that is generated, it might be presumed that any frequency could be generated at will. Such is nearly the case. With one of the ordinary tubes obtainable for small transmitters the writer has produced frequencies as low as one cycle a second by use of large inductances and condensers, whereas the same tube with the smallest inductances and condensers feasible has generated ten million cycles a second. These are not necessarily limits; it is possible for one who has large and efficient coils to go lower than one a second and

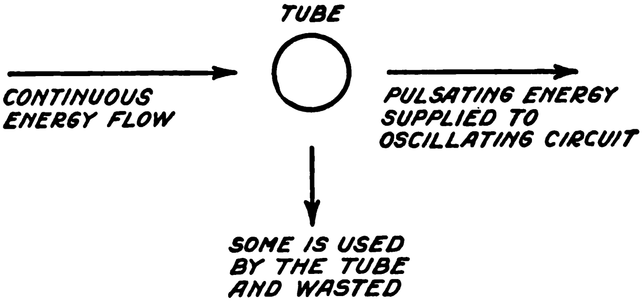

TUBE
CONTINUOUS ENERGY FLOW
PULSATING ENERGY SUPPLIED TO OSCILLATING CIRCUIT
SOME IS USED BY THE TUBE AND WASTED

FIGURE 1: *The elements of an oscillating tube. This diagram illustrates in simple form the action that takes place within the oscillating vacuum tube.*

by using proper care in the selection and arrangement of the apparatus the upper frequency can be pushed as high as three hundred million cycles a second—a wide enough frequency range to suit almost everyone!

The amount of power output of an oscillating tube is limited entirely by the amount supplied by the continuous current machine that furnishes the power to the plate circuit; only a certain fraction of this can be transformed into alternating current power. The power supplied by the continuous current machine is equal to the product of its voltage and current, hence to have a large output from a tube its plate circuit must be arranged to stand high voltage and its filament must be sufficiently large to liberate a great many electrons without operating the filament at such a high temperature that its life would be short. In the smaller tubes used for transmitting about 500 volts pressure is used in the plate circuit and a current of about 30 milliamperes is permissible, thus requiring from the plate circuit generator 15 watts of power. As an efficiency of 30 per cent is common in these tubes as generally used, the amount of alternating current power available is about 5 watts, which is the rating of the small transmitting tubes.

For more power, larger filaments are required and the arrangement of connections in the tube must be such that high voltages may be applied between the plates and filament. Tubes are now being made for experimental purposes which permit an electron current from filament to plate of 60 amperes and which permit a voltage in the plate circuit of 15,000 volts. As the efficiency of these larger tubes can be made much higher than it is for the smaller tubes (just as is the case for any electrical machinery) we may figure on an efficiency of 80 per cent to 90 per cent, so that the output would be measured in the hundreds of kilowatts. Of course, these powerful tubes cannot follow the same constructional lines as the smaller tubes; they are made of metal instead of glass, and all the parts of the tube must be arranged for cooling by circulating water through jackets properly built into the tube.

For a given tube, well constructed and evacuated, there are two prime factors which serve to limit the safe output: the safe filament temperature and the safe plate temperature. Excess values of either will materially shorten the life of the tube.

An oscillating power tube may be either separately excited or self-excited, the same as any continuous current generator. In case but one tube is being used it must evidently be self-excited, but if three or more are used better results will be obtained by using one of them (self-excited) to excite the grid circuits of the others. The writer has always found it possible to get more power out of three tubes by using one of them as an exciter and the other two as power amplifiers than if all of them were used to deliver power to the antenna. It is easier to control the various required adjustments for separately excited tubes than for those self-excited.

It is especially advisable to use separately excited tubes for short wave telegraph transmission because of the greater constancy of the frequency generated; if self-excitation is used the frequency of oscillation is determined by the capacity of the antenna and any change in this capacity will affect the frequency sent out. If double frequency amplifiers (Armstrong's super-heterodyne) are used for receiving, the reception will be comparatively poor.

The safe output of an ordinary tube is fixed by the heating of the plate. The largest tubes used by amateurs have a safe plate rating of 250 watts. If the tube is adjusted for 50 percent efficiency it is evident that the maximum safe output of the tube is 250 watts. Suppose that by a suitable adjustment the efficiency could be raised to 90 percent, what would be the safe output of the tube? Again the safe output would be fixed by the fact that there must be no more than 250 watts used on the plate, but with 90 percent efficiency, when the loss on the plates is 250 watts, the output of the tube will be 2250 watts; that is, the possible output has been increased something like ten times!

It is easy to state the conditions which must be obtained in a tube to get its maximum efficiency for any given filament current and plate voltage, but it is not quite so easy to furnish these conditions on an actual set. A comprehensive study of the question of triode efficiency was made by the writer, with the assistance of Mr. Trap Friis, and the results were published in the Proceedings of the A. I. E. E. for October, 1919. This seems to be the only work on record in English that shows the necessary conditions for maximum efficiency and how to obtain them.

The grid potential and plate potential of a tube fluctuate as the tube generates alternating current power, generally following the form of a sine wave. For best conditions the plate voltage must fluctuate an amount nearly equal to the voltage of the machine in the plate circuit. For example, if a 500-volt generator is used in the plate circuit the plate voltage should fluctuate from about 50 volts to 950 volts, the exact amount depending somewhat on the structure of the triode. The proper value of the lower limit (50 volts) is very important in determining the efficiency, but it can only be given accurately when the exact characteristics of the tube are

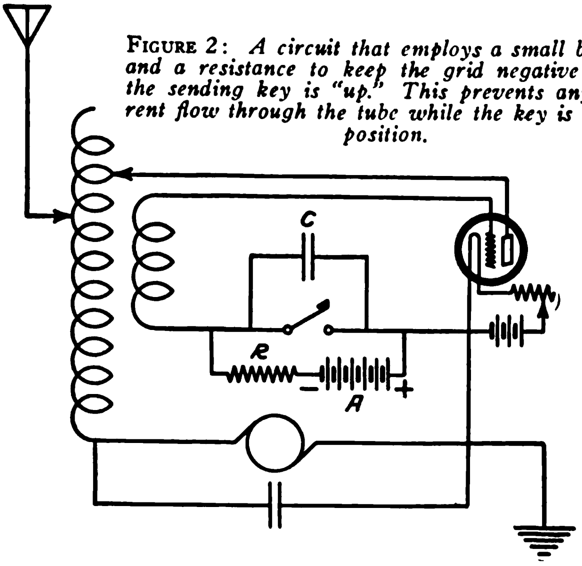


FIGURE 2: *A circuit that employs a small battery and a resistance to keep the grid negative while the sending key is "up." This prevents any current flow through the tube while the key is in this position.*

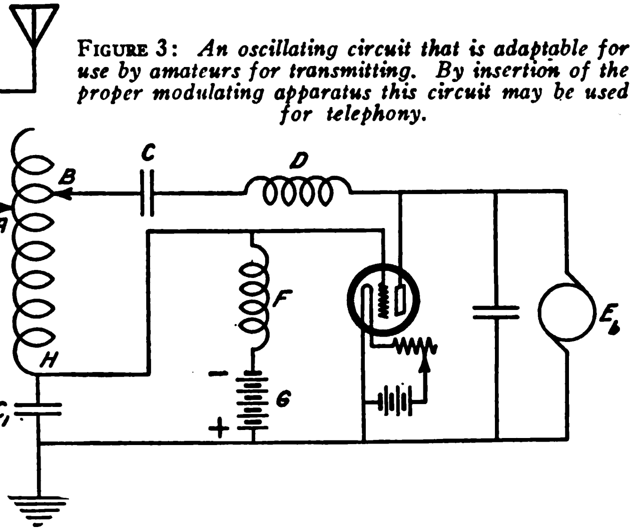


FIGURE 3: *An oscillating circuit that is adaptable for use by amateurs for transmitting. By insertion of the proper modulating apparatus this circuit may be used for telephony.*

known. The article cited above deals with this point in detail.

The grid potential must fluctuate by an amount about equal to the fluctuation of plate voltage multiplied by the factor $W_0/2$ where W_0 is the theoretical voltage amplification factor of the tube, generally about five for the small power tubes sold for amateur use. The amount of grid bias voltage (always negative) should be so chosen that when the grid voltage has its maximum positive value it is nearly equal to the minimum plate voltage. This condition may be obtained either by the use of a C battery of small dry cells or by the use of a suitable grid condenser and grid leak. In either case a high frequency choke coil should be placed between the grid and ground (filament connection) to prevent the use of excessive power in exciting the grid.

Not only must the proper magnitudes of grid and plate voltage fluctuations be obtained, as given above, but the relative phases of the two must be accurately adjusted. The phase of the two must be exactly 180 degrees apart, so that the maximum positive grid potential occurs simultaneously with the minimum value of plate voltage. This is an important point to observe if the maximum output of the tube is to be obtained, and is the most difficult condition to fulfil when the tube is using self-excitation.

The fourth condition has to do with the load circuit. In the case of separate excitation the natural frequency must be the same as the frequency of the exciter and for either separate or self-excitation, the effective resistance of the antenna circuit, between the two points where the tube supplies the alternating current power, must be equal to the alternating current resistance of the plate circuit of the tube. This is nearly equal to (but always somewhat less than) the voltage of the B machine divided by the continuous current furnished by this machine.

It is possible, of course, to put the transmitting key directly in series with the antenna circuit if but little power is being generated, if opening the circuit at the point selected does not also interrupt the current from the B machine. It is generally better, however, to put the key in the grid circuit, thus cutting off the excitation of the tube when no signals are being sent out.

Whenever possible the key should be so placed that when the key is "up" no plate current flows from the B machine; in this case when no signals are being sent (all the time the key is up) the plates are being cooled off and also not so much power is used from the B generator. If this connection is properly made the safe output of the tube is nearly twice as much as if this precaution is not observed.

Thus if a tube is rated at 12 watts safe power on the plate and the above condition is satisfied, the circuit may be adjusted so that when the key is down the power dissipated on the plates is 20 watts, and still the plates will not overheat.

In the case of highly evacuated tungsten filament tubes this may be accomplished by leaving the grid "free" or "floating" when the key is up; with oxide coated filament tubes this free grid is a dangerous condition and should never be tried. The free grid of a well evacuated tungsten tube will practically always be negative, thus cutting the plate current down to a very small value. The free grid of an oxide coated filament tube may suddenly go positive, in which case the plate current increases to a dangerous value and the tube is spoiled in a few seconds; in fact, they many times "blow up," breaking all the internal structure.

For these oxide filament tubes it is best to have the key so inserted that when it is up the grid is forced to a proper negative value by a battery of small dry cells, as indicated in Fig. 2. With the key up the voltage of cells A forces the grid to become so negative that the plate current is brought to practically zero and when the key is down the cells are "shorted" through the high resistance R, which is sufficiently high (say 50,000 ohms) so that the current which flows from the cells doesn't materially affect their life. A small condenser C across the switch points will eliminate whatever slight sparking might occur. Using this scheme it is possible for a small hand key to successfully control kilowatts of power in the antenna.

When the conditions for best efficiency are obtained it often happens that the tube is sluggish in "picking up" when the switch is closed, thus not permitting rapid sending; for this reason as well as for the others cited above, it is best to have the power tubes excited by a separate tube, which is continually left in the oscillating state.

Of course, every one finds his "best" circuit by using that in which he gets most power out of his tubes. But any circuit which permits the fulfillment of the conditions analyzed will be as efficient as any other.

A circuit certainly as convenient as any is shown in Fig. 3. This is the one used most frequently by the writer. A coil H, A, B, is wound with sufficient inductance so that combined with the capacity of the antenna it will give frequencies considerably lower than any which it is desired to generate. It has about twelve taps, say every second turn is brought out for making connection to it by a clip. Condenser C_1 is a mica condenser with four or five values, the minimum being about equal to the antenna capacity; a better but more expensive set-up uses a variable condenser in this place. F and D are high frequency chokes of about one millihenry each. C is an insulating (or blocking) condenser of say 0.1 microfarad. G is the biasing battery of a few small dry cells; for the ordinary 5-watt tube 20 cells will do.

The wavelength sent out is controlled by the position of contact A. The grid excitation is controlled by the size of condenser C_1; it should generally be about twice the capacity of the antenna. The position of contact B affects the wavelength slightly but its principal function is to make the effective resistance of the antenna, as measured between contact B and ground, equal to the plate circuit resistance of the tube. The amount of bias voltage in battery G affects the efficiency of the tube primarily; this, and the capacity of the condenser C_1, should be varied together in adjusting for maximum efficiency. For small power the sending key can be placed in the antenna circuit between condenser C_1 and ground. If the maximum safe output is desired the grid should be excited through a condenser and the key arranged as shown in Fig. 2.

For the single tube transmitter this circuit arrangement seems as good as any.

From a photograph made for POPULAR RADIO

A DEMONSTRATION OF THE "TALKING CRYSTAL"

Without the aid of a battery or other electric generator, Dr. A. M. Nicholson, who developed what is called "Piezo electricity," enables his audience to listen in on music broadcasted by radio.

The Voice in a Lump *of* Salt

How Crystals Are Made to Yield the Beautiful Supersensitive "Pressure Electricity." Today a Laboratory Stunt but Tomorrow—What?

By JAMES H. COLLINS

RATHER a dirty looking chunk of something or other—like paraffine melted up with fine sand. And a queer shape—flat on one side and a squatty pyramid on the other. It might be a setting lost out of the ring of a very untidy giant.

It is wrapped with a ribbon of tinfoil, clamped between two aluminum plates and squeezed a little by springs. Finally it is hooked up in an electrical circuit.

"Now listen!" the visitor is told, and he is handed a pair of telephone receivers. He hears the music from a phonograph in another room—it would travel just as well from another city. Sound cannot be transmitted over a telephone wire without electric current. But there is no battery on this circuit. The queer-shaped object clamped between the aluminum plates is furnishing the intermittent currents. Tested with a voltmeter it would register as much as 500 volts on twisting the object with the fingers.

Then it is hooked up to a powerful

vacuum tube amplifier and is laid on a sheet of paper. One edge of the paper lifted with the fingers produces a sound as though somebody were ripping clapboards off a house. The ticking of a watch laid on the paper sounds like a pile-driver at work. A grain of sugar is laid on the paper; presently a fly lights and begins investigating. The feet of a fly have suction pads—that is what enables him to walk on the ceiling. His promenade around the sugar sounds like a cow wading through a mudhole!

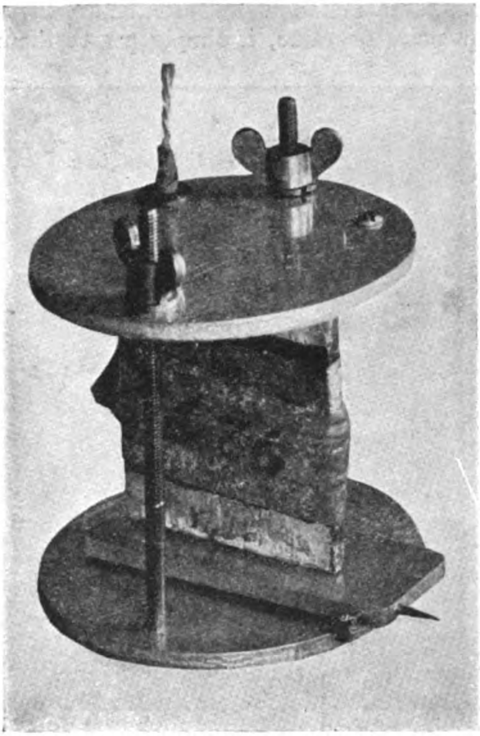
The strange object is a crystal. We are in a room devoted to crystal-electrical research in the big New York laboratory of the Western Electric Company, the guests of Mr. A. McLean Nicolson, who might be called a "crystal farmer," for besides studying the electrical phenomena of crystals he has to grow them from "seed crystals." He is showing us the "piezo-electric" property of "pressure electricity," of certain crystals which were discovered by the Curies. "Piezo" is from the Greek "piezein" which means "to press." Torsion applied to these crystals converts mechanical energy into electrical energy, following certain lines in its crystalline arrangement or pattern. Why certain inorganic crystals like quartz and gems should have taken different patterns in cooling from molten liquids or gases in the remote ages when the globe was young, or why organic substances like sugar and certain salts should cool from liquid into different patterns, is one of the unsolved riddles of matter. But a most fascinating riddle! For if matter as we perceive it through our senses is nothing more than electrical energy working in the impalpable ether (and no scientist has ever detected the ether by the most delicate apparatus) then in this electrical phenomenon found in crystals we are leaning over the very eaves of the material universe and looking into its ether abysses. That is to say, looking into the Everlasting Nothing—from the standpoint of mere humans.

You can push speculation along this line so far into mathematics and metaphysics that it is comfortable to find a material chair under you and see material ships out the laboratory window doing their chores up and down the North River, and hear the blunt question of a matter-of-fact visitor:

"Well, what practical use can you put it to? Will it make a better crystal detector for radio?"

Just what the skeptical man in the street wanted to know when Sir William Ramsay isolated argon and helium, "But what are they good for?" And science itself couldn't then predict that in less than thirty years we would be using one in electric light bulbs and the other to make safer dirigibles.

"During the war, we used these crystals as submarine detectors," explains



Western Electric

THE "TALKING CRYSTAL" HARNESSED

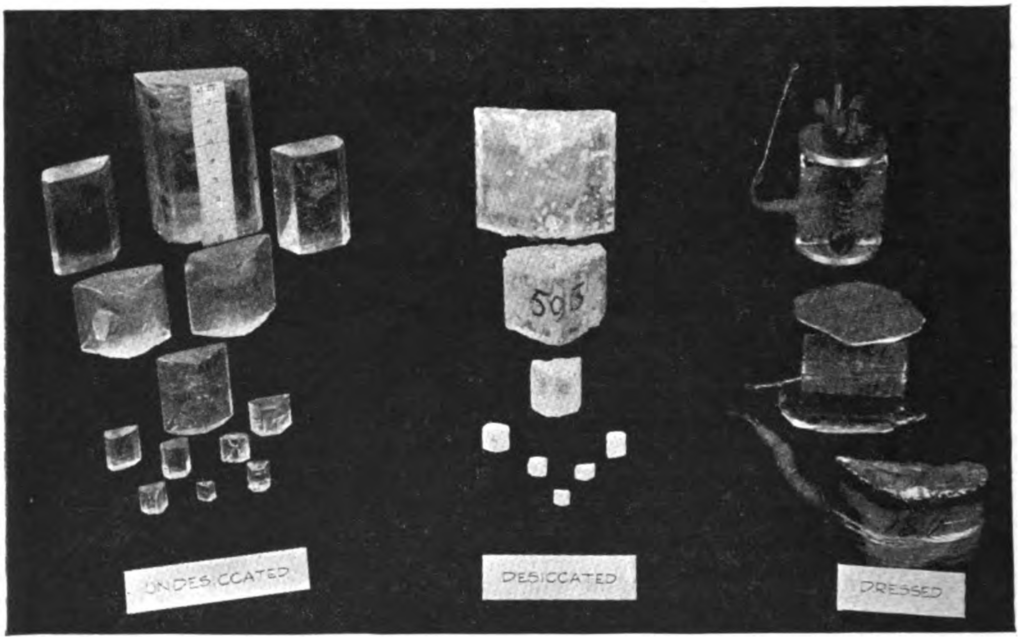
Showing how the artificially-made crystal is squeezed between two aluminum plates and connected in circuit to give out electricity.

Mr. Nicholson. "Placed in watertight cans, dropped over the side of a ship and connected with a telephone circuit, their supersensitiveness revealed the vibration from a submarine propeller several miles away. But we haven't found a real workaday job for them yet."

The time may come when crystals will replace the carbon microphones in the telephone transmitter and receiver, but there is no immediate practical application in sight, and the physicist refuses to make any predictions. They have no advantage in radio telephony because, while many amateurs use galena, carborundum and other crystals as detectors, this type of crystal is "different." The radio crystal detector is a rectifier. It changes the inaudible high frequencies that are transmitted through the ether into lower frequencies capable of acting upon a telephone receiver. But while this crystal is sensitive enough to detect the high frequencies of radio, it simply passes them along without changing potential, and for radio purposes it would have to be connected with something else. The crystal radio detector is only a makeshift anyway. We have the ideal detector in the vacuum tube, the only reason why it is not universally used being that it is somewhat expensive compared with crystals.

The present problem is to find better kinds of crystals, and learn more about the organic crystals generally—which is where "crystal farming" comes in, a field of investigation in which amateurs might help and find an interesting hobby. This requires some chemical knowledge, but is not difficult and should appeal to those who take an interest in pure science and like to extend their knowledge by experiment.

None of the inorganic crystals so far investigated have any great degree of sensitiveness—the quartz and gem crystals that Nature grew millions of years



Western Electric

THE THREE STAGES IN THE CREATION OF THE PIEZO CRYSTALS

These bits of crystals, grown from seeds in the laboratory, are as clear and pretty as gems when they first come from the solution. After they are "desiccated" (or baked and shrunk), they are "dressed"—meaning that they are covered with varnish and tinfoil.

From a photograph made for POPULAR RADIO

HOW THE CRYSTALS ARE MADE

The best crystals are made of Rochelle salts, but good effects have been obtained from various kinds of sugars, especially from common rock sugar. Even ice is a crystal from which piezo effects may be obtained.

ago. Only the organic crystals grown in the laboratory become satisfactory generators or transmitters of electricity under torsion. The best of them all thus far found is the crystal of Rochelle salt, a product of the juice of the grape. For practical purposes it has shortcomings, it is easily damaged by humidity, for one thing.

Relatively few of the many salts, sugars, tartrates and so forth, have been investigated. As an illustration of the field to be explored the writer told Mr. Nicolson about the rare sugar work of another investigator, Mr. T. Swann Harding, who is producing a dozen or more little-known sugars for bacteriologists. Harding's sugars are a queer lot. One of them is a bitter sugar, several are unfermentable, and another is extracted from pants buttons, so to speak—the vegetable ivory trimmings from button factories.

"There you are!" he said enthusiastically. "The only sugar we have tested for the piezo-electrical effect is the common rock sugar of the candy store."

If Mr. Harding can grow better crystals for Mr. Nicolson, they will still have to make a horse trade on costs, for some of the rare sugars fetch several hundred dollars a pound!

Crystals are grown in several ways. Like plants, each particular substance thrives best under certain conditions. The purpose of growing the crystals is to get them in masses large enough to generate or transmit sufficient electricity. The growing process is really freezing. Incidentally, ice is a crystal, and snow, probably with the piezo-electrical effect, but they have obvious shortcomings.

The Rochelle salt crystals are obtained by heating a solution of the salt in water and cooling it to supersaturation rapidly, in about twelve hours. A small "seed" crystal is added as the liquid cools, and the salt grows around it, taking its characteristic crystal formation. Masses weighing two pounds have been grown, but they are usually defective. After growing, the "raw" crystal must be "desiccated" or baked. This dries and cures it, shrinking the size and increasing its electrical properties. It also improves with time, if it is not affected by atmospheric conditions. Mr. Nicolson has crystals which, after several years' use, are just as effective as ever, and in some ways more effective than newly grown crystals. Its production of electricity takes nothing from the crystal. Put under compression and torsion, it gives out electricity, and when released it takes up electricity. A handy comparison is with a sponge, from which water can be squeezed, and which will take up water when the pressure is relaxed, yet nothing is taken from the sponge in the process.

After the crystals have grown and are baked, they must be dressed—coated with a special varnish and fitted with tin-foil electrodes. The small seed crystals used in growing the larger ones are obtained from previous croppings or by disturbing the solution in which crystallization is taking place, this causing it to break up in many small crystals.

Kelvin reasoned that matter is nothing more than electric swirls or "vortex rings" in the ether, comparable to smoke rings. If they swirl without friction they will go on forever. But if there is the slightest modicum of friction, eventually the material universe must run down and disappear. That will happen so many aeons in the future that we needn't worry about it, but it is inevitable just the same.

The Hindus hold that the visible material universe is simply the "breathing out" of Brahma into the invisible spiritual universe.

"I will realize and express myself through material manifestations," says Brahma, and his out-breathing is the energy that makes spirit appear as matter—or the ether as Kelvin's vortex rings in terms of modern science. But there is an in-breathing, too, and when Brahma breathes in again, the material universe disappears and an unthinkably vast cycle of creation ends, and the universe rests in spirit until another out-breathing.

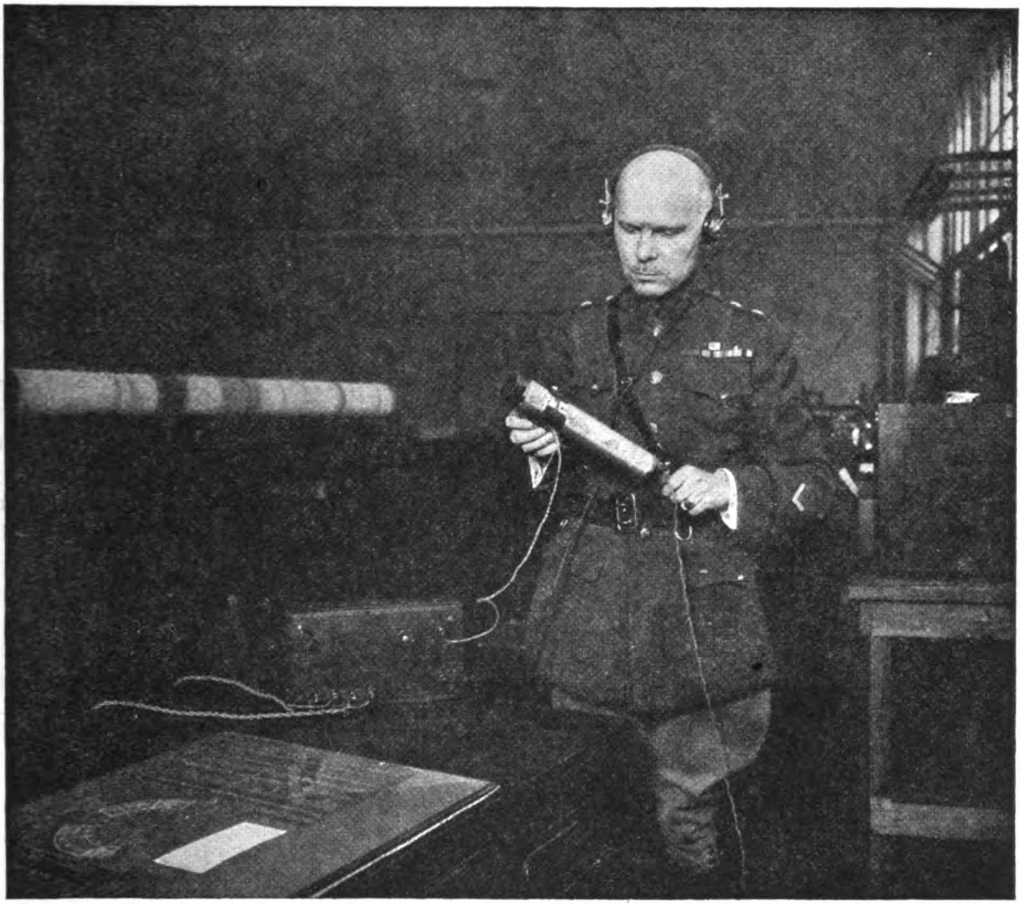
Kelvin didn't find Brahma, nor carry the microcosm of his vortex ring to the microcosm of Brahma's cycle. But his physical and mathematical results suggest that the Hindus may not be, after all, so far off in their metaphysical conception of the universe.

In the piezo-electrical phenomena of crystals, as in radio communication, we are perhaps dealing with the basic stuff of the universe—certainly the finest states of matter. And we are using some of them to enormously extend the range of human intelligence, so pitifully blanketed under its dense robes of flesh.

Yesterday radio communication was a beautiful laboratory plaything, useless to the practical man. What it has since become, the piezo-electrical effect of crystals may become tomorrow.

What Will Take the Place of Today's Broadcasting?

Publication of Major General George O. Squier's article on this live topic has been postponed from this issue—for which it was announced—to the next issue, October. This change will enable the General to include in his article some timely material that was not available earlier. Ask your newsdealer to reserve your copy.



U. S. Signal Corps

THE MOST EXCLUSIVE ANTENNA IN THE WORLD

By merely sliding the ring along this miniature resonance wave coil—thereby changing the wavelengths which are received—Major-General Squier, the inventor of this device, is enabled to keep out not only the wavelengths he does not want, but also most of the static that comes along with them.

A Resonance Wave Coil *for* Reducing Static

By S. R. WINTERS

BY the use of a so-called "resonance wave coil"—which is in effect a complete and compact wireless antenna—the Signal Corps of the United States Army reports that it has developed a method whereby "static," the persistent disturber of orderly radio communications, may be practically eliminated. This discordant element in the reception of radio signals is operative from June to October—about five of the twelve months in the year—and has always been one of the retarding factors in the development of the radio art.

The invention of the Signal Corps for eliminating static takes the form of a drain coil of wire. The incoming signals from broadcasting stations, for instance, traverse the so-termed "resonance wave coil" and then proceed to the conventional radio-telephone receiving outfit, irrespective of the design—vacuum tube or crystal set. But this coil of wire or compact antenna is of a discriminating caliber and only radio signals are admitted into the radio-telephone receiver, while the static electricity is sidetracked and conveyed to the ground. Such are the claims made for this new form of "static eliminator."

The length of the drain coil varies with the distance traversed by the communications that are to be received. The strength of the incoming wireless signals are not robbed of their strength by the draining process. Moreover, facilities are accessible for amplifying the messages as required.

"Eliminating static noises has been one of the most serious problems in radio development," says Dr. Louis Cohen, consulting engineer of the Signal Corps of the United States Army. "Due to the electrical charges in the atmosphere, especially in summer, even the largest stations must shut down at times. This device represents a new and radical departure in receiving radio signals. The method consists in receiving the radio signal, passing it through a very long coil which drains off the interfering disturbances and leaves the full strength signal without noises."

This resonance coil obviates the need of a receiving apparatus other than a detector and a pair of telephones; indeed, it has been fittingly described as a "vest-pocket edition of wireless equipment," and is adaptable to service in the absence of ground connection, either actual or counterpoise. As a transmitter, the device tunes its own waves and is a single-unit direction finder.

The experimental unit of the resonance wave coil built by the Signal Corps is of a hollow cardboard design, 38 inches long and 2¾ inches in diameter, around which is threaded a single layer of No. 32-gauge insulated wire. This afforded 100 windings to the inch. Terminal binding posts are placed at each end of this tube or coil. A brass band or ring, a fixture of the compact antenna, is supplied with the binding post. This ring in its formation is interrupted by a split ¼ of an inch wide at a point opposite to the binding post. This break avoids interference from disturbing eddy currents. The ring is of ample size to slip snugly over the wired tube. The coil is pivoted to swing to any angle in the vertical plane. A dial on the base of the framework indicates the compass direction of the tube, and another dial, facing the operator, reflects the degree of elevation.

A resonance wave coil of the dimensions indicated is capable of receiving signals ranging upward to a wavelength of 1,200 meters. Contrary to the operating principle of former designs of tuning coils, the shortest wave point on this device is at the center of the coil. If the tube is in a position exactly at right angles to incoming electro-magnetic waves, the brass ring may be moved toward either end of the coil as a means of tuning to the incoming signals. In other words, there are two points along the coil, located at equal distances from its center toward either end, where 600-meter wavelengths will be audible. By the same token, at two points, a bit farther along on both ends of the coil, 750-meter wavelengths may be received.

When the tube was located in the Washington laboratories of the Signal Corps, wireless signals from the radio-telegraph station of the United States Navy Department in Cuba could be heard distinctly. The reduction of static electricity to a minimum by the use of the resonance wave coil inspired the Signal Corps to apply the principles of this device to the development of this static eliminator.

A Rotary Condenser Usually Costs from $5.00 to $25.00. But You Can Make One Yourself for Less Than $2.00

From a photograph made for POPULAR RADIO

How *to* Make Your Own ROTARY PLATE CONDENSER

Another of the Practical Little "How to Build" Articles for the Novice

By A. HYATT VERRILL

IN some ways the rotary type condenser is a little more desirable than the sliding type. It occupies less space, it looks neater, and a finer adjustment can be obtained with it. On the other hand, it is perhaps a trifle more difficult to construct, but if you use a little care, you will not have the slightest difficulty in building a rotary plate condenser that will serve as well as the most expensive ready-made instruments.

Although the condenser described here has 23 plates, the number of plates may be varied to suit the requirements and you may make one with 11, 23, 43 or any other number of plates in exactly the same manner, the only difference being in the length of screws. But in each case, the dimensions of plates, base and top given, as well as the sizes of screws, washers and other parts may remain the same.

Before commencing work on the condenser, or for that matter on any instrument, it is a wise plan to study the directions carefully, before beginning work. By studying the directions until you thoroughly understand each step in the construction you will avoid mistakes which are apt to occur if you go ahead with the work and trust to following directions as you proceed. Ordinary tools, such as a screwdriver, drills, hack saw and files are all that are required, but a

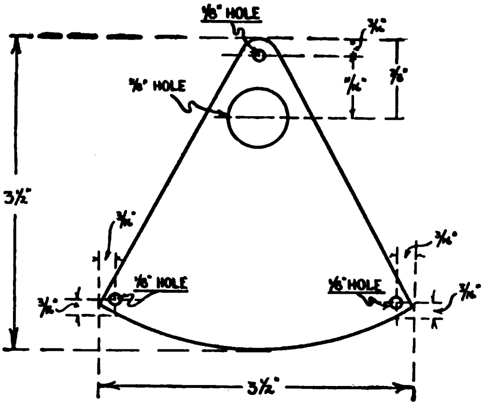


FIG. 1

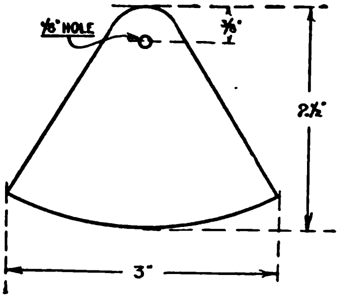


FIG. 2

set of taps and dies will prove a great help.

As the sheet aluminum in this condenser is fairly thick, you will save time and trouble if you secure a pair of tinners' snips or get the local tinsmith to cut the plates for you, although there is little difficulty in cutting the sheets with a hack saw and then trimming the rough edges with a file. Be very careful, however, not to bend or buckle the plates, for if you expect good results they must be absolutely flat and even.

The supplies required will be a sheet of ⅛-inch Bakelite or Formica large enough to give you two pieces each 3½ by 3¾ inches in size. A supply of sheet aluminum 1/16 inch thick and large enough to give you the 23 plates. As each plate takes a piece 3¾ inches square, you can readily figure this out, or better still, mark the patterns on a sheet of paper or card and measure the size required.

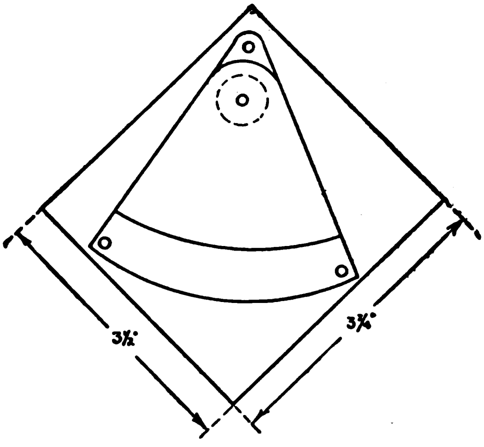


FIG. 3.

You will also need about four dozen brass or copper washers ⅜ inch in diameter and 3/16 inch thick with a hole ⅛ inch in the center. If you cannot get washers of this thickness, use several thinner washers. They may vary 1/32 of an inch in diameter without harm. You will also need a few similar washers 1/16 inch thick. You must also have four ⅛-inch brass screws four inches long, a number of nuts to fit these, two binding posts, a little wire and two bushings of either brass or fibre 3/16 inch thick and ¼ inch in diameter with a hole ⅛ inch in diameter. If you cannot secure these you may make them by cutting off short sections of brass or fibre tubing of the right size, or you may use a number of 1/16-inch washers of the right thickness to make the desired size.

The first thing to do is to scale off the patterns for the plates, shown in Figures 1 and 2, to full size on a sheet of stiff paper or thin cardboard. Do this with a pair of compasses and a ruler and be sure to get all the measurements exact as upon this depends the whole success of the condenser. Cut these patterns from the card and using them as guides, mark around them on the aluminum and cut out the plates. There should be twelve of Figure 2 and eleven of Figure 1.

Next cut the two blocks of Bakelite or Formica 3½ by ¾ inches. Place one piece of the Bakelite on the other and pile the plates on them as in Figure 3, placing the larger plates first, then the smaller, and being sure that all the edges are even as shown. When all are arranged, clamp plates and panels firmly in a vise and bore the holes through all at the exact spots and distances shown. Then remove the plates and panel and clamp the larger plates alone in the vise with a piece of board behind them, after arranging them so all holes are in perfect alignment. If you run ⅛-inch rods through the three holes at the corners it will be easy to align them.

With a reamer or a large drill, cut the hole marked ⅝ inch to that size. Ream the corresponding holes in the panels to ¼ inch. The worst of the work is now done and all that is necessary is to assemble the condenser.

Insert the four brass bolts 4 inches long and ⅛ inch in diameter in the four holes in one of the panels and turn the panel over so the heads of the screw bolts are underneath. Slip one of the 3/16 by ⅜ inch washers over the bolt placed in the large hole in the panel.

Slip one of the bushings 3/16 by ¼ inch over this central bolt and push it into the ¼-inch hole in the panel.

Place one of the 1/16 by ⅜-inch washers over each of the three corner bolts but not on the one in the large hole.

Slide one of the large aluminum plates over the bolts, pushing it down until it rests firmly against the three 1/16-inch washers.

Place one of the ⅜ by 3/16-inch washers over each of the four screws and work that upon the bolt in the large hole down through the large hole in the plate until it rests against the panel and the bushing, as shown in Figure 4.

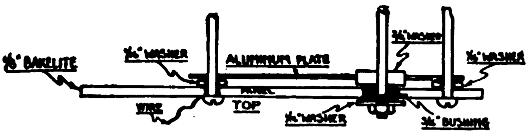


Fig. 4

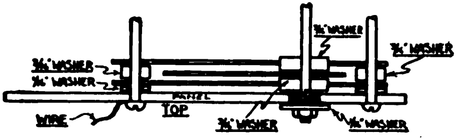


Fig. 5

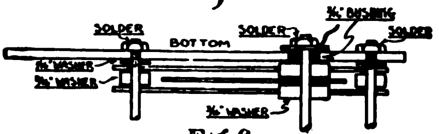


Fig. 6

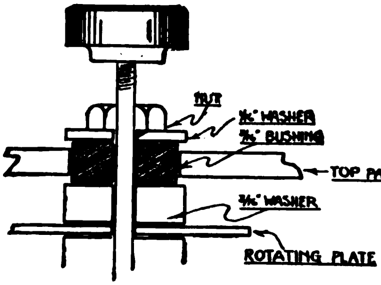


Fig. 7A

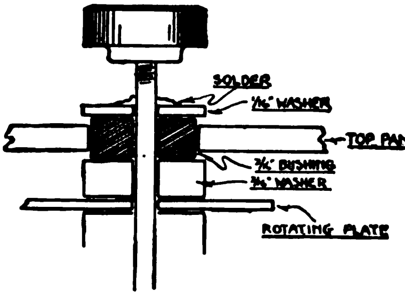


Fig. 7B

Slip one of the small aluminum plates over the bolts and slide it down until it rests upon the washer on the central bolt but do not bend it or buckle it. Let it lie loosely. Put another one of the ⅜ by 3/16-inch washers over each of the four bolts and slip on another large plate. It will now be as in Figure 5. Continue

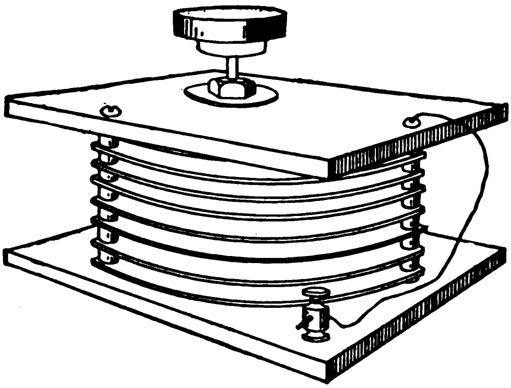


FIG. 8

putting on plates and washers in the same order until all are on.

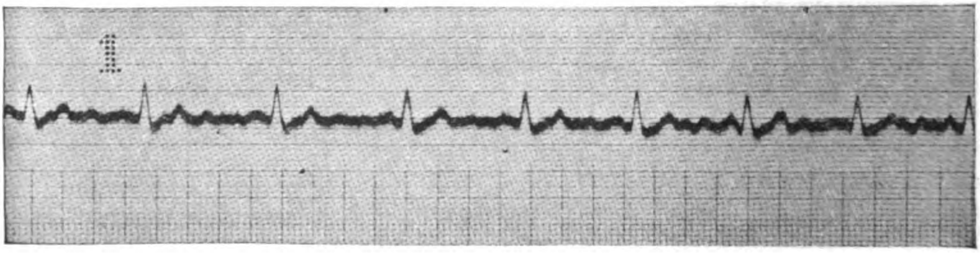
When the last large plate has been slipped over the bolts, place a 3/16 by ⅜ inch washer on the central bolt and a 1/16-inch washer on each of the other three as in Figure 6. Slip the second piece of Bakelite over the bolts. Place the second ¼ by 3/16 inch bushing over the central bolt, fit it in the hole in the panel and place one of the 1/16 by ⅜ inch washers over it.

Place nuts on the three corner bolts and twist a wire a few inches in length around the head of one of them and screw the nuts on firmly, tightening first one and then another. When these are all tight, slip a nut on the central bolt, turn it on for a few threads and turn the entire affair right side up.

If you have used a screw headed bolt for the central one you must solder the thin washer above the bushing to the bolt, but if you have used a threaded end rod you should screw a nut down against the washer as shown in Figure 7. In the first case, after soldering, tighten up gradually upon the nut at the opposite end of the bolt until the smaller plates bind slightly between the washers. Then swing them out from between the large plates until you can get at them and while holding the edges in perfect alignment, tighten up on the nut until the plates are securely bound together.

If a threaded end rod has been used, you may tighten up on the top nut instead of on the bottom. When all this is done, fit a knob or handle to the top of this central bolt as shown in Figure 7. Solder a short section of wire to the lower end of this bolt. Solder the nuts to the bolts all around. Lead the two wires to binding posts at the corners of the lower panel as shown and place small leather headed tacks or any other similar devices upon the under surface of the base so that it will rest evenly without bearing on the bolt ends.

The finished condenser should appear as in Figure 8, ready to connect to your set. By rotating the knob, you can vary the capacity of the condenser, thus accomplishing your tuning.



AN ELECTRIC PORTRAIT OF ANXIETY

Radio is entering into medical circles; some of the same radio apparatus that is used for receiving purposes is now being employed by doctors for recording the nervous reactions of patients. The above graph, for example, is an "electrocardiogram" that shows the cardiac current of a woman during a moment of worry over the safety of her jewels which she had left in the dressing room! How radio is being used by doctors will be told by Dr. Henry Smith Williams in a near issue of POPULAR RADIO.

Radio Fans Who Are Paid *to* Learn

WHAT THE NATIONAL GUARDSMAN IS DOING WITH WIRELESS

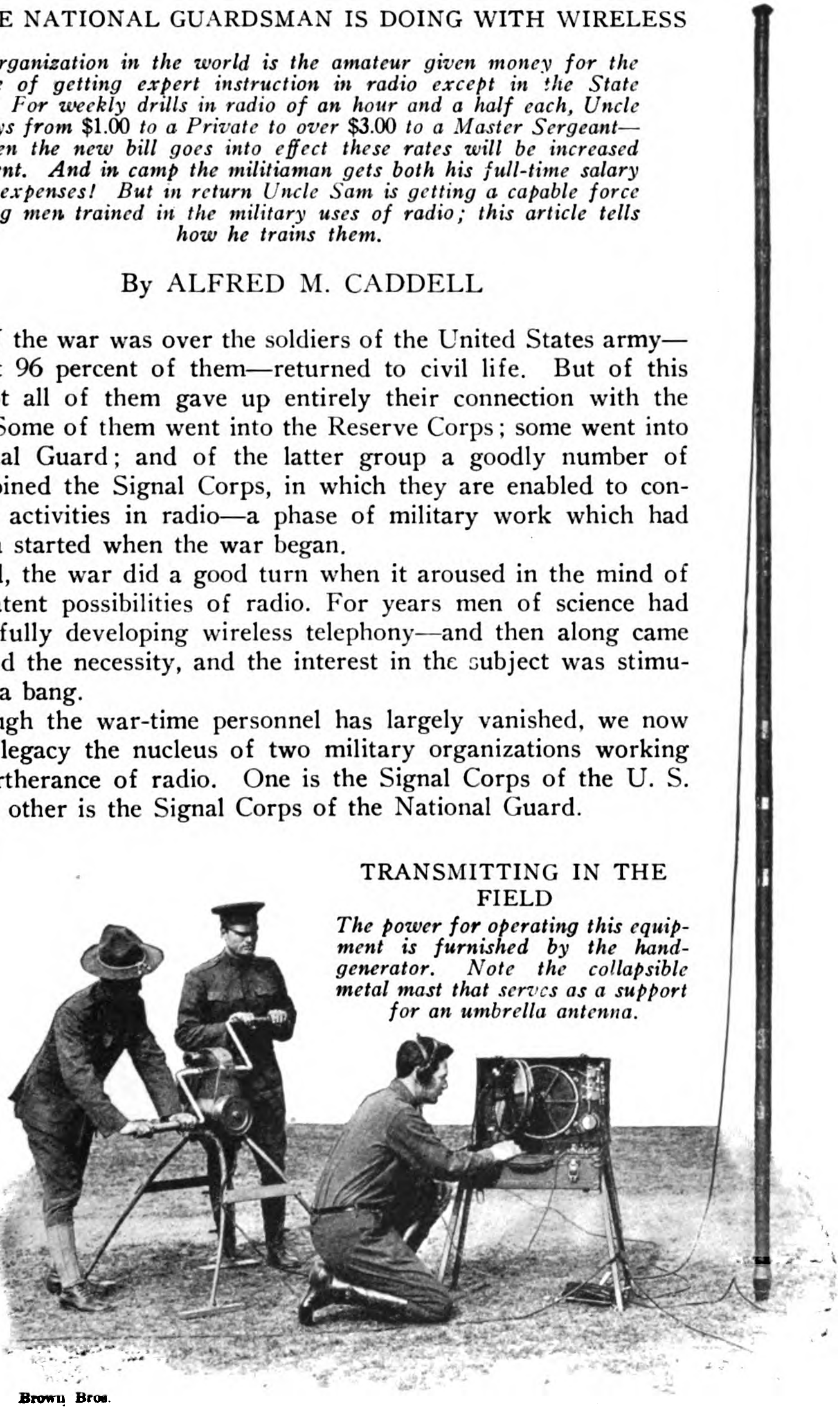
In no organization in the world is the amateur given money for the privilege of getting expert instruction in radio except in the State Militia. For weekly drills in radio of an hour and a half each, Uncle Sam pays from $1.00 to a Private to over $3.00 to a Master Sergeant—and when the new bill goes into effect these rates will be increased 80 percent. And in camp the militiaman gets both his full-time salary and his expenses! But in return Uncle Sam is getting a capable force of young men trained in the military uses of radio; this article tells how he trains them.

By ALFRED M. CADDELL

WHEN the war was over the soldiers of the United States army—about 96 percent of them—returned to civil life. But of this number not all of them gave up entirely their connection with the military. Some of them went into the Reserve Corps; some went into the National Guard; and of the latter group a goodly number of veterans joined the Signal Corps, in which they are enabled to continue their activities in radio—a phase of military work which had barely been started when the war began.

Indeed, the war did a good turn when it aroused in the mind of men the latent possibilities of radio. For years men of science had been peacefully developing wireless telephony—and then along came the war and the necessity, and the interest in the subject was stimulated with a bang.

Although the war-time personnel has largely vanished, we now have as a legacy the nucleus of two military organizations working for the furtherance of radio. One is the Signal Corps of the U. S. Army; the other is the Signal Corps of the National Guard.



TRANSMITTING IN THE FIELD

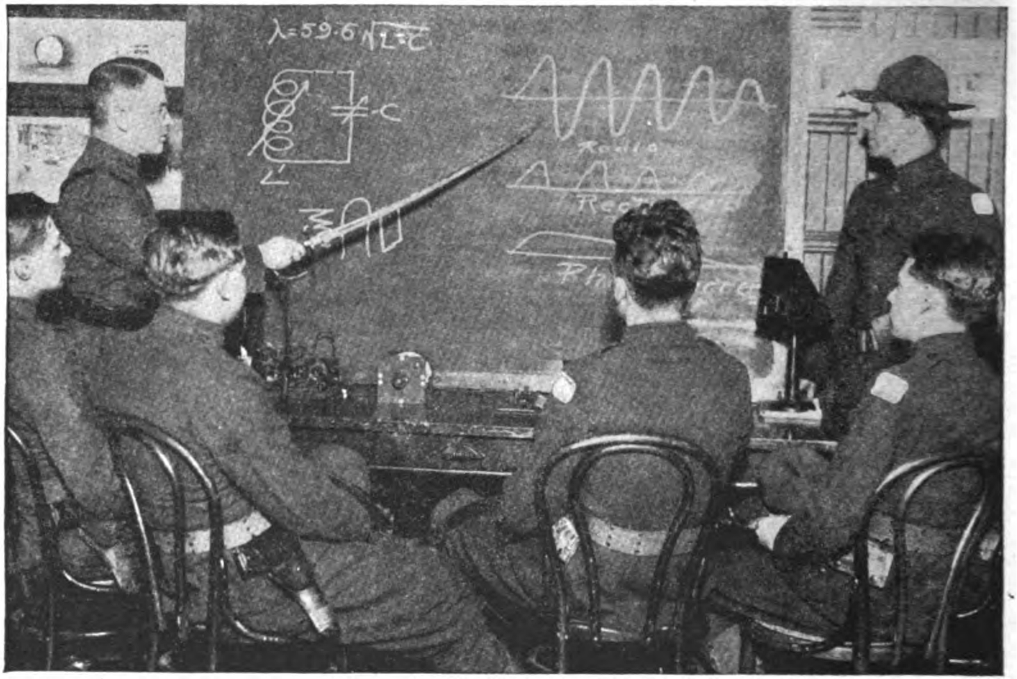
The power for operating this equipment is furnished by the hand-generator. Note the collapsible metal mast that serves as a support for an umbrella antenna.

Brown Bros.

One of the best of the National Guard organizations devoted to radio is the 101st Signal Battalion, Second Corps Headquarters, located in New York. It was formerly known as the 102d Field Signal Battalion of the 27th Division. For purposes of illustration of what the National Guard can do in radio work, it may be accepted as representative. It has an authorized war strength of 17 officers and 460 men, although at present it is composed of only 14 officers and 156 men. The battalion is in command of Major James C. Fox, and is composed of two companies, A and B. The latter is the radio company.

Company B is composed mainly of operators and maintenance men capable of handling the actual transmission of messages. Their work covers the operation of the radio net, consisting of tractor and truck sets, and of maintaining (trouble shooting) and operating the lines as constructed by A Company or taken over from the enemy. They speak as freely of polarities and eccentricities of electrical phenomena as a mother would relate the habits of her child. Yes, the boys have wireless down pat. At times their talk sounds a little bewildering to the layman—vacuum tubes, condensers, wavelengths, amplifiers, decrement. They have been drilled and schooled until radio has become part of their being. We'll get acquainted first at headquarters, and then accompany them on a camping trip where actual warfare is simulated, where they go through all the manoeuvres, establish message centers, send and receive all kinds of "copy" over the waves of the "chartered" ether.

We are the spectators at a Monday or a Thursday night drill. Expectancy fills the air. B Company assembles on the



International

IN ORDER THAT THE MEN MAY COMPREHEND THE PRACTICE, THEY ARE TAUGHT THE THEORY

This class-room scene does not constitute a "drill" as the average guardsman knows it. But such classes are included in the instruction course in radio—and an important part they are, too.

From a photograph made for POPULAR RADIO

ON ACTIVE DUTY WITH THE ARMY'S "RADIO NET"—WHICH IS BEING EXTENDED OVER THE WHOLE COUNTRY

The first duty of the stations in this net is to handle the traffic of the Amateur Radio Reserve, which transmits radio messages for the army. But they also relay messages for others—free of charge.

big floor of the armory, equipment in hand,—poles on which to string a V-type antenna, generators, sending and receiving sets, head gears. The command is given:

"Open station!"

Every man is at his post. In less than three minutes' time the antennae are up, messages are broadcasted or received and couriers are ready for quick dispatch to "headquarters."

"Station BG4 testing; calling 2BHA. Station BG4 testing; calling 2BHA. Station BG4 testing; calling 2BHA."

The operator is speaking into the radiophone. A slight pause, then possibly a brightening of the operator's face as an answer comes over the ether waves. Or possibly not, as the case might be, for BG4 may have to tune in on a different wavelength and call again before 2BHA can hear him. Station 2BHA may be at the further extremity of Long Island, or up at Niagara Falls. It is all a matter of his detector picking up or not picking up the wavelength sent out by BG4.

The instruction work of the radio company is essentially practical. It maintains telegraph classes and code classes, and it teaches the men to read by the sounder or buzzer, so that they become familiar with wire lines as well as radio. The men are taught how to operate and maintain the instruments. The company also has what is known as a field buzzer set, on which the continental code is used; it is similar to a telegraph line, but is intended for special use in the field; likewise it has a "buzzerphone," an ingenious instrument first adopted by the British during the World War and called a "Fullerphone." This was perfected by the Signal Corps and utilized by the A. E. F. The buzzerphone is used in the front lines and can be employed for telegraph code or phone. Telephony is not permitted except where there is no possibility of being heard by enemy listening-in posts. The buzzerphone, however, cannot be intercepted as it operates on low potential and both sending and receiving stations must be tuned to one another and all ground potentials balanced out.

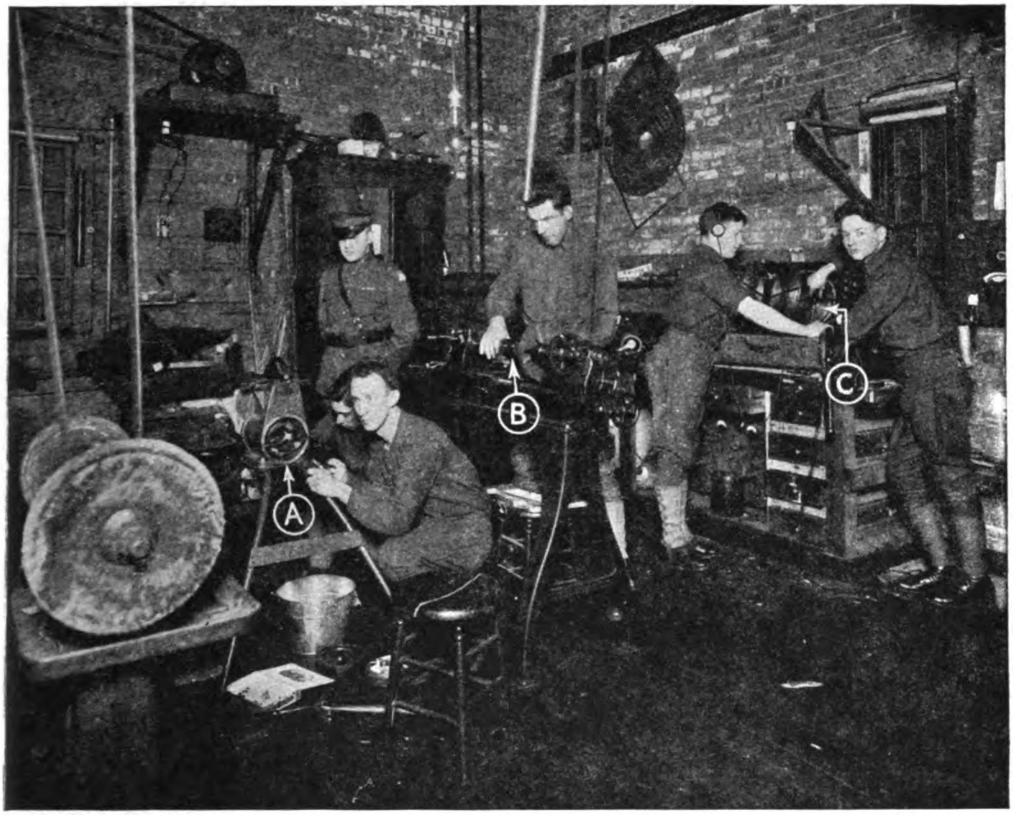
The radio company has regular schedules for drill nights, during which it operates radio with the army stations of the 2nd Corps, and maintains communication with amateurs in the handling of traffic. Many of the men, after learning radio technique in the classes, install sets in their own homes. The radio course extends over a period of twelve weeks, and is then repeated; it covers all practical applications of radio phenomena. This class is open to all members of the battalion.

There are the different sets to be used and kept in working condition. There are practice sets as well as sets for broadcasting and receiving. The men are enabled to keep up with new developments, as apparatus and equipment are constantly being changed and added. A recruit is allowed to sit in at the classes and be systematically coached. There is nothing more important than to encourage him in his quest for knowledge about radio; a cheery word and a slap on the back promotes his enthusiasm—and enthusiasm in the work pays the government mighty good dividends. Perhaps the recruit wants to specialize in the air service; perhaps he has visions of himself talking from an airplane or balloon. All well and good—there is an airplane set for him to practice on. Perhaps he wants to operate the radio "net;" indeed, he won't be allowed to forget that! But meanwhile, as a member of the National Guard, he is being paid for attending drill and learning.

Not all the activities center around teaching recruits, however, nor around the mere exchange of messages with this station or that. The battalion functions in what is known as a radio "net," which transmits government messages that ordinarily would have gone over telegraph wires from Washington to the army corps headquarters located in various sections of the country. This net has effected a large saving to the government in wire tolls. The long-distance stations linked together in an "army net" permit the distribution by radio of army orders and other official communications that emanate from Washington to the corps centers. Thus Washington is in direct touch with Fort Sheridan, Chicago, which in turn connects with Fort Crook, Omaha, and on out to Fort Douglas, Utah, and to the Presidio, San Francisco, and the 9th Corps headquarters. This forms the central trunk line of communication across the country, while a similar border trunk system runs by way of a relay at Fort Sam Houston, Texas, to San Francisco. A total of 1,627 messages aggregating 71,295 words was handled during the first two months the army radio "nets" were in operation. The Amateur Radio Reserve assists in the relay of such messages; operators of the radio company are on duty two hours every evening for this purpose. Altogether, therefore, the work is varied, profitable and intensely interesting.

During the summer the men of the 101st Signal Battalion convert armory training into field practice. Let us travel along with them and get an insight into their field work.

Around the middle of August the battalion entrains for its Peekskill camp. Heretofore the outfit has been mounted, and while mount practice is still included in the training, the unit is now completely motorized. In fact, quickness and ease of mobility is a prime necessity of its work. This year, for example, the



From a photograph made for POPULAR RADIO

THE MEN ARE TAUGHT HOW TO REPAIR RADIO APPARATUS

Soldiers in the field cannot drop into a mechanic's shop to have their equipment fixed up, nor can they ship it back to the factory. So they do the job themselves in a shop of their own. The men are shown (A) dismounting a hand generator; (B) resurfacing a commutator and (C) repairing inductances.

corps has at its disposal four motor trucks equipped with radio sets capable of an efficient range of 500 miles, together with trucks, motorcycles and other appliances needed for a unit of this size.

The men motor to Peekskill. They strike camp, say, late in the day. They come upon a town in a valley, perhaps a peaceful village with only a few telegraph and telephone facilities. A "war" is in progress. They "seize" whatever facilities there are and operate them. A detachment is ordered to an outlying point that is well guarded from shell fire, with instructions to establish a radio station. This forms part of the net, and is connected up by wire lines to headquarters, message centers and other units as required. This station, if working with division units, would likewise have a division radio set for relaying traffic received from army or corps headquarters. The men like these detached service jobs because they are placed on their own initiative, usually under the command of a non-commissioned officer. Small details are dispatched along the land lines—at test points to watch for lines going out of service. These men are supplied with motorcycles or light cars to do the "trouble shooting" and see that the lines are kept in service. Should the lines go out, radio fills the gap.

The use of radio, however, fulfills a mission scarcely conceived by a non-military man—that of invisible scout. For by use of goniometric apparatus, which was developed by the French in the late war, compass bearings can be obtained rapidly on any station that sends a message. By triangulating, or taking the bearings from each of a series of goniometric stations in a given enemy area, and charting the point of intersection of those bearings, the location of enemy stations operating radio with each other can be determined. The data thus gathered is then given the artillery, which then aims to destroy the enemy station. Thus war conditions can be largely simulated.

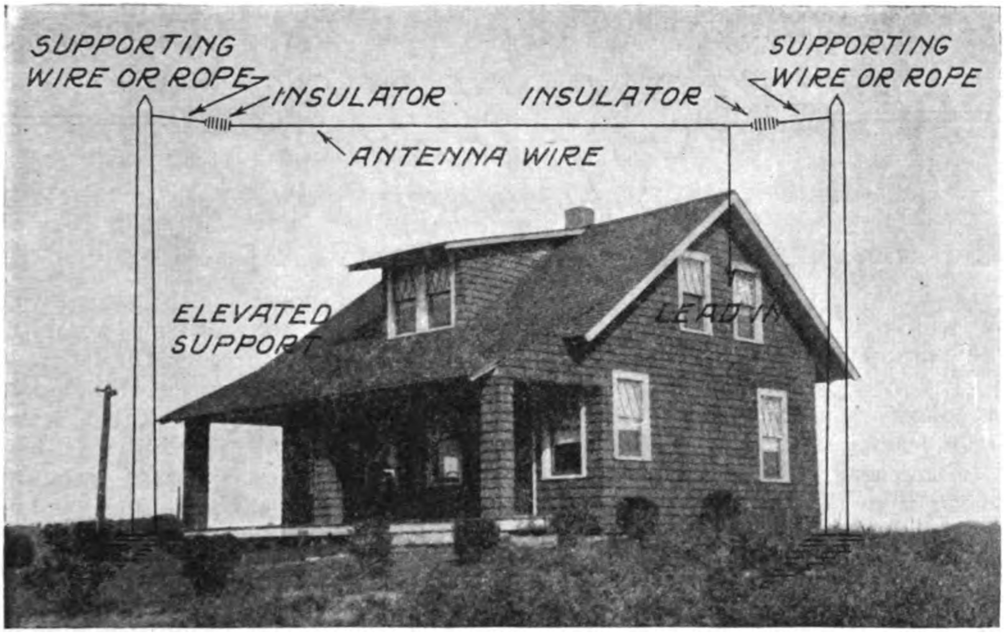
The apparatus used by the corps unit is known as the SCR-99, which has a working range up to 100 miles. It is compact and easy to transport; it consists of VT-1 tubes for receiving and VT-2 for transmitting on wave lengths between 900 and 1500 meters C. W.—320 volts on the plate of the transmitting tubes. The SCR-97 is used for communication with airplanes, as it has a telephone transmitter; in field practice, however, the actual required working distance is seldom more than fifty miles, different units overlapping one another. But should the unit find itself in a bad locality, camouflaged in the woods, handicapped by bad static conditions, the excess power will then come in to advantage in overcoming any possible trouble.

Big things are being planned for radio in many National Guard activities—more intercommunicating stations, more unfolding of radio possibilities, more trained men. Indeed, the development of radio in the National Guard has barely begun. The most interesting work lies ahead.

From a photograph made for POPULAR RADIO

LEARNING THE CODE BECOMES A GAME WHEN IT IS TAUGHT IN CLASSES

There is a big difference between studying the code alone and in company with other beginners. Fifteen minutes of concentrated study a day will enable the average student to receive code messages within a month.



THE BEST ANTENNA FOR RECEIVING BROADCASTS
A single-wire inverted L-type antenna. The two elevated supports—in this case poles—may be used only in cases where trees or buildings are not available.

The Simplest Receiving Antenna

THE INVERTED L-TYPE

The First of a Series of Short Articles on the Various Types of Antennae and Their Uses

By DAVID LAY

Since the advent of radiophone broadcasting, there has been such a great amount of interest created in radio, and so many receiving sets installed and antennae erected, that one can look out of almost any window in a large city, and see at least one or more antennae or "aerials" as they are popularly called, stretched along the skyline. Some of them are high ones, some of them are low ones, some are short, some are long, some look neat and some look mangled, some are insulated, and some are not, some work well, some fairly well, some poorly, and some do not work at all.

Very few of the beginners who erect their antennae know what they are doing. Some of them have not the slightest idea what it is all about; they just follow the directions and "String up a single wire, about 100 feet long, and as free from surrounding objects as possible."

The antenna and the ground connection form the means of converting the radio waves into electrical oscillations, and if the antenna is inefficient, how can we expect the results to be satisfactory? Even though we have good apparatus, if the antenna does not convert the waves into electrical impulses strong enough to operate the set, we cannot expect the set to work.

This series of short descriptions of the different conventional types of antenna is written to give the beginner an idea of the structural details of the antenna as well

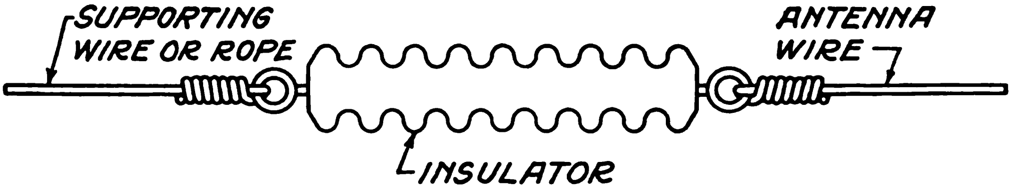


FIGURE I

How the insulator is fastened to the antenna wire and to the supporting wire.

as the uses of the different types so that he will know which type is best suited to his purpose and how to build it.

The type which has gained greatest popularity on account of its simplicity and general usefulness is the inverted "L" antenna. The "L" antenna gets its name from the likeness of its shape to an inverted letter "L."

For broadcast reception the L antenna is usually made of one single wire stretched between two high supports, with an insulator at each end of the wire. The lead in wire is attached (soldered) to the antenna wire at one end and brought down as straight as possible, to the receiving instruments, as in the diagrams on the accompanying photograph. The insulators are attached to ten foot lengths of supporting wires (or ropes) which are fastened to the elevated supports. The supports may be poles, high buildings, large trees, or other elevated structures.

The insulators are used to prevent the currents induced in the antenna by the passing radio waves, from leaking down the elevated supports to the ground without going to the receiving apparatus. These insulators are sold in the radio supply stores and are made of some kind of good insulating material that is waterproof. They are usually made in a tubular corrugated shape to make the surface leakage path across them as long as possible. Two metallic rings are fastened at the ends of the insulator for connecting to the antenna and supporting wires. An insulator of this type is shown in the diagram in Figure 1.

The length of the antenna wire stretched between the insulators should be approximately 100 feet.

The L type antenna will receive better from the two directions in which the antenna wire points than in other directions, and will receive best from the direction in which the lead-in end points.

For transmitting on 200 meters, the L antenna is made with more than one wire in the antenna proper. Four wires are usually used. With this construction, two insulators are used at the ends of

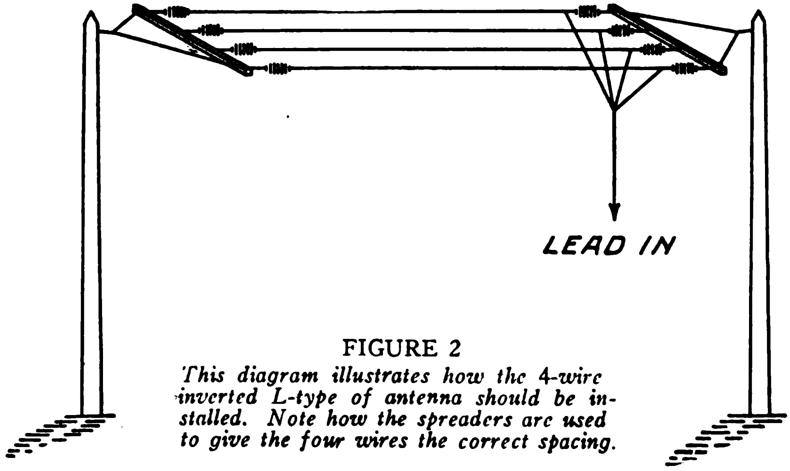


FIGURE 2

This diagram illustrates how the 4-wire inverted L-type of antenna should be installed. Note how the spreaders are used to give the four wires the correct spacing.

each wire as shown in Figure 2. The wires should be spaced at least two feet apart. This is accomplished by the use of two wooden "spreaders," each six feet long. These should be made of hard wood sticks, two inches square. The sticks are connected to the elevated supports by means of wires (or ropes) as shown in the diagram. Four lead-in wires are soldered to one end of the four antenna wires and these are brought to a common junction from which a single wire is run down to the instruments.

This latter type of antenna may be used for both sending and receiving and has a greater electrical capacity than the single wire antenna. It has about the same directional characteristics as the single wire antenna.

Its inductance is of about the same value as the single wire antenna, but its capacity is much greater and this is the main reason for its superiority for use in transmitting. Each of these adaptations of the inverted L antenna should be constructed as high in the air as possible, especially in cases when the antenna is to be used for transmission, as the effective height of the antenna greatly affects the sending range.

The "T" type antenna will be described in a near issue of POPULAR RADIO.

RADIOGRAMS

BY A. J. DE LONG

A MAN *fell off the roof yesterday and broke his antennae.*

* *

THE *station that is issued the call letters GOD will have a lot of publicity to start with.*

* *

ANYBODY *who can throw a stone into a pool of water ought to understand the fundamentals of broadcasting.*

* *

A YOUNG *man who has been saving his money doesn't know whether to buy a radio set or get married.*

* *

WHAT *a radio fan needs is a shop that will repair vacuum tubes while you wait.*

* *

THE *trouble with most folks is that when they get a station good, the program is spoiled because they wonder what another place is doing.*

* *

WHAT *makes the dog scratch so? Maybe he's got the radio bug.*

* *

WHY *the lights in the boxes? That's to show the sound waves the path to the receivers.*

* *

A BEGINNER *wants to know if it's the scarcity of radium that makes radio equipment so high.*

* *

NEXT *to the lady who is always knitting on a street-car few things are as annoying as the man who is always getting distance stations.*

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

IN order to make this department of greatest help to the beginner, it is possible to publish only those questions which are of the widest application and of most general interest. To insure prompt attention and to help the Technical Editor in handling the large amount of correspondence which the department has developed, our readers are asked to observe the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: Will you give me a hookup for a receiving set that employs a variometer and variocoupler and a detector tube, and batteries? What kind of batteries and what kind of receivers are best? Would a one thousand ohm receiver work?

WM. H. F. REHON

ANSWER: A circuit diagram for connecting the apparatus you wish to use is shown in Figure 1. You will need the following additional apparatus however:
1 Variable condenser, .001 mfd. capacity
1 2-megohm grid leak R_1
1 Grid condenser, 0003 mfd. capacity.
1 5-ohm filament rheostat R_2
1 22½ volt "B" battery
1 6-volt storage battery, 40 to 60 ampere-hour
1 pair 2000 or 3000-ohm telephones

You may obtain the batteries at any radio supply store; ask for them as indicated in the list. The 1000-ohm telephones are not as sensitive as the higher impedance telephones.

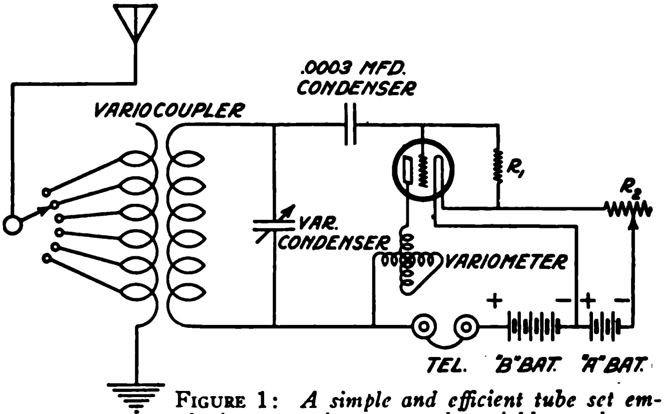


FIGURE 1: *A simple and efficient tube set employing a variometer and variable condenser. The variocoupler insures selectivity.*

QUESTION: I am building a receiving set that employs one stage of amplification, two variometers with a Paragon control panel, and also a 4-circuit telephone jack and a 2-circuit jack. I do not understand the connections of the control panel. Kindly publish a hook-up for it.

GEO. DUFFNER

ANSWER: The diagram in Figure 2 clearly shows the connections for the complete set.

* * *

QUESTION: What is the difference between a UV-200 tube and a UV-201 tube and what are their uses?

A. ALLEN

ANSWER: The two types of vacuum tubes mentioned are similar in details of construction, and their only difference is in the degree of evacuation of gases in the tube. All tubes containing an incandescent filament must be evacuated to a certain extent to prevent the filaments from burning up when heated to a white heat, that is, the oxygen in the air in the tube must be pumped out so that the filament will not oxidize and burn out. The UV-200 tube is not evacuated to such a high degree of vacuum as the UV-201. A small amount of gas is left in the UV-200 which permits the use of larger plate currents with reduced plate voltages. This is because the gas left in the tube tends to ionize and thus make the space between the filament and the plate more conductive. The UV-200 is used for a detector, and the UV-201 is used as an amplifier.

* * *

QUESTION: I have a Manhattan 7-plate condenser (variable) and would like to know where to hook it up. I have tried it in series with my aerial and also in series with my ground, but I find that the signals and the programs of broadcasting stations come in louder without it. Mine is a number 15 tapped coil, 2 switch set, using a crystal detector.

Can you tell me how to construct a variocoupler?

Is radiocite better than galena?

A. JACOBSON

ANSWER: The capacity of your condenser is too small to do any good in either your antenna or ground circuits. The only place it will be of any use with your present set is connected across the secondary circuit of the coil.

We will publish in a near future issue an article showing how to build your own variocoupler.

This article will explain to you in detail the construction of the instrument, which should work to good advantage in your set.

Radiocite and galena are both very sensitive crystal detectors, and there is not much choice between them.

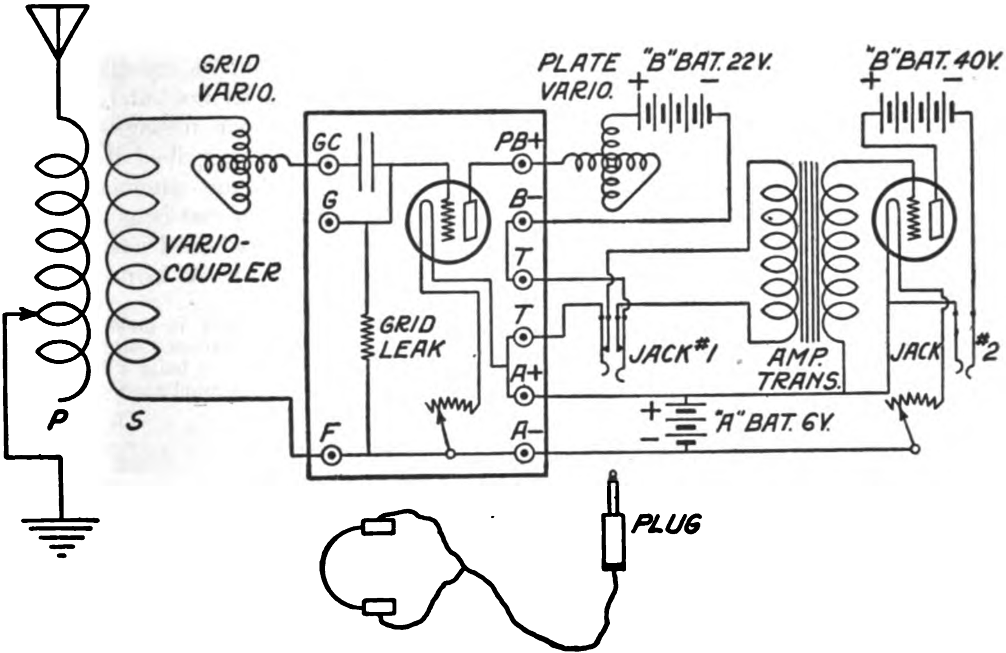


FIGURE 2: *Connections for adding one step of amplification to a Paragon control panel using a 4-circuit telephone jack and a 2-circuit jack.*

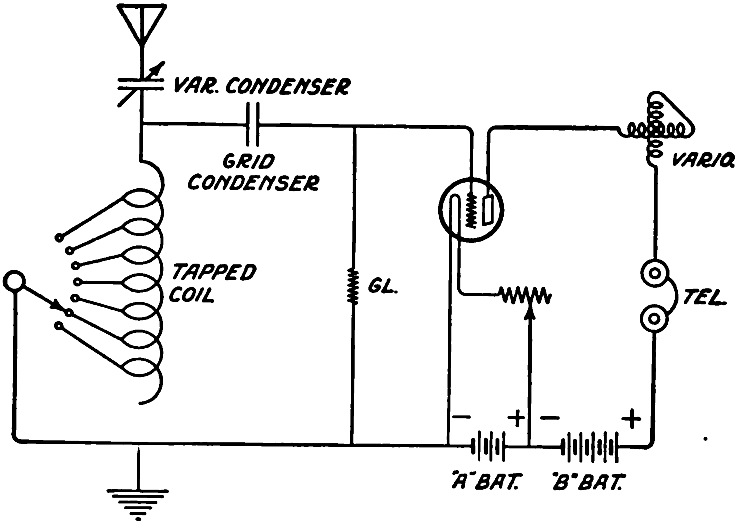


Figure 3: *A simple regenerative hook-up in which the antenna circuit is tuned with a condenser, the secondary is tuned with the tapped coil, and the plate circuit is tuned by a variometer.*

Question: I cannot hear anything on my regenerative receiver, as shown in my diagram. What is the trouble?

Geo. H. Struble

Answer: We have drawn the circuit correctly for you; if you use it as shown in Figure 3 your set will work.

* * *

Question: What is the difference between a regenerative and a non-regenerative receiving set?

C. Pearson

Answer: Regeneration in this sense means throwing the incoming signal back upon the oscillation transformer (or loose coupler, as it is often called), in such a way that the signal will reinforce itself. This is done through a coil inserted in the amplifying circuit and placed in inductive relation to the oscillation transformer. A common circuit of this type is one which employs a third honeycomb coil.

* * *

Question: Why are honeycomb coils better than ordinary coils? Will you tell me how to make one?

Hayward Hewson

Answer: In a honeycomb coil there is a minimum of distributed capacity, as the wires are some distance apart except where they cross. By using such a coil, the proper amount of inductance may be inserted in a circuit without adding as much capacity as is commonly found in other types of coils.

It is almost impossible for an amateur to wind a honeycomb coil satisfactorily. To wind such a coil by hand would require many hours of tedious labor. As the coils the amateur requires are not expensive, it is better for him to buy them. until some young inventor can perfect a home-made winding machine.

* * *

Question: I built a crystal set described in Popular Radio, but I can hear nothing with it but code messages. I built the set just as you described it. Could the trouble be with my antenna? It is about 25 feet long, as that is as long as I can possibly make it where I now live.

S. A. Lounsbury

Answer: The trouble is undoubtedly in your antenna. If you cannot make it longer, the next best remedy is to build a loop aerial and use radio frequency amplification if necessary.

* * *

Question: Is my small switch sufficient to protect my house against lightning? Where can I find out?

A. J. Wilson

Answer: Any fire insurance agent can furnish you with a list of regulations. There are many other stipulations which you should know if your house is insured against fire.

QUESTION: Please publish a hook-up of a radio set with which I can receive a distance of 300 miles. This hook-up should use a loose coupler, one grid leak, one grid condenser, one rheostat, socket, and "A" and "B" batteries. C. FRED SYLVESTER

ANSWER: In Figure 4 is a hook-up that uses the instruments you find obtainable. But they cannot be arranged to receive over the distance you require.

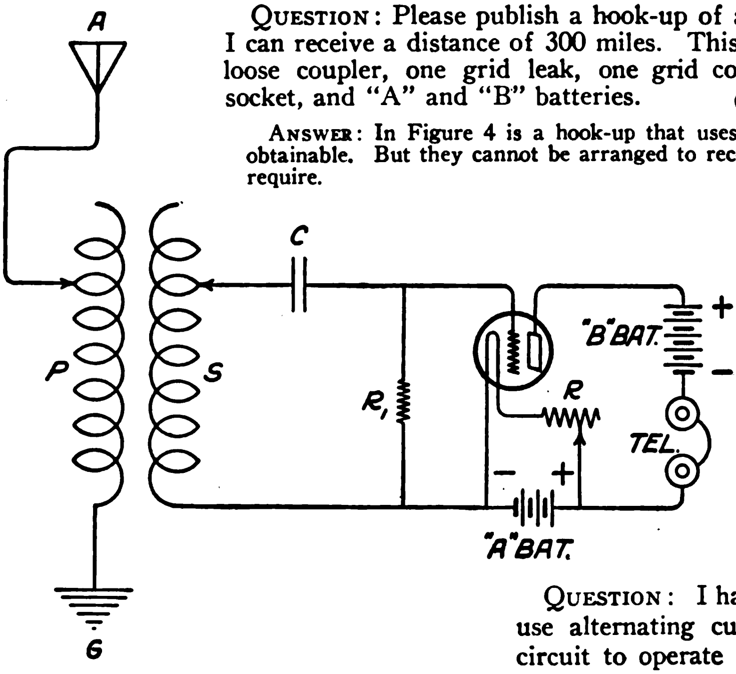


FIGURE 4
A straight audion circuit that employs a loose coupler for tuning.

QUESTION: Is it always necessary to place a variable condenser in the antenna circuit?

C. T. SMITH

ANSWER: This is not necessary unless your antenna is too long for you to get down to the proper wavelength. A condenser used in this way shortens the natural wavelength of the antenna circuit. The ordinary antenna circuit is easily tuned with inductance alone.

QUESTION: I have been told that I can use alternating current from the house circuit to operate my set. Can you tell me how?

A. H. FRANZ

ANSWER: In a future number of this magazine such a hook-up will be explained in detail. It is somewhat complicated, and you should understand it thoroughly before you try it, so that you will not damage your set.

* * *

QUESTION: I have a two-slide tuning coil, crystal detector, condenser, loading coil and buzzer test. I would like to know how to connect them. Can you show me how?

W. A. RANDALL

ANSWER: The circuit diagram that you require is shown in Figure 5.

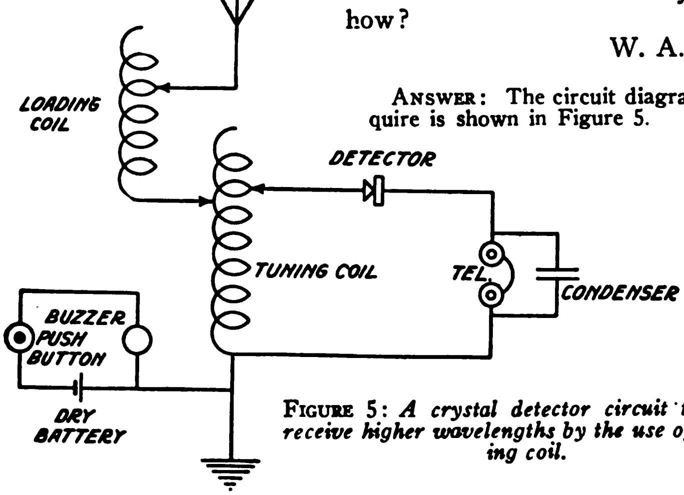


FIGURE 5: *A crystal detector circuit that will receive higher wavelengths by the use of a loading coil.*

THIS *department—conducted by a patent attorney of wide experience in radio work—will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

An Arc Converter

Patent No. 1,410,730; R. R. Beal, Palo Alto, California.

IT is estimated that the arc converter is responsible for around 80 per cent of the energy that is radiated into space by transmitters—other than amateur transmitters.

There are two types of transmitters: the damped wave transmitter and undamped wave transmitter.

In the first system the amplitude of the wave train that is radiated decreases or dies down just as the amplitude of a vibrating string or tuning fork dies down if force is not continuously applied to it. This is called damping. A spark transmitter is an example of a transmitter of the damped wave type.

Continuous or undamped waves may be radiated by the use of an alternator, electron tubes or an arc converter; such continuous waves are used in the transmission of speech and music. Although broadcasting or speech transmission is at present done by means of electron tube transmitters, yet the arc converter has possibilities for such transmission when fully developed, especially for transoceanic transmission. For that reason, and also because of its extensive use in radio telegraphy, it is of interest.

The apparatus illustrated in Figures 1 and 2 represents an arc converter. It reminds one of the old street arc lamp with its spaced carbon electrodes and electromagnets for "striking the arc" and to keep it going as the carbons wear away; it also reminds one of an electric furnace. In the arc converter as used in radio the magnet is for the purpose of assisting in steadying the arc, and for deionizing the gap by blowing the "ions" away—a magnetic breath, as it were.

The Beal converter illustrated is in two segments 2-3, which are hinged together at 4. These segments comprise casings 5 and 6 of magnetic material (steel), the opposite ends of which are closed by transverse plates 7 and 15 of similar magnetic material. To the plates 7 and 15 are secured the magnetic cores 8 and 16, surrounded by the magnetic windings 9 and 17-18-19 respectively. The cores 8 and 16 are arranged axially with the converter and their inner adjacent ends are slightly spaced from each other on line with the plans of contact of the two segments 2 and 3. The magnet coils are held in position by means of the plates 12 and 21 and bolts 13. Between the magnet coils is the narrow arc chamber formed by the plates 14 and 22; these plates are formed with passages 15 and 23, through which water may circulate for cooling purposes.

The electrodes 25 and 27 are arranged on the lower segment in the chamber formed by plates 14 and 22 and at right angles to each other; the gap between the electrodes is located between the spaced ends of the electromagnet. The cathode or negative carbon electrode 25 is supported in the holder 24, and the anode or positive electrode 27 is supported in the holder 26. Arranged on the top of the apparatus is a hydrocarbon liquid feed cup 28, from which the hydrocarbon drips through conduit 29 into the electrode chamber. An exhaust pipe 31 permits discharge of exhausted atmosphere from the electrode chamber.

The apparatus here described appears simple in construction and resembles the old arc lamp, yet when properly connected in circuits it has the power of "converting" direct current into high frequency alternating current which causes the radiation of continuous undamped electro-magnetic waves when properly connected to an antenna. The circuit for an arc converter comprises a generator or dynamo, generating a direct current, say of 500 volts, electrically connected to the electrodes 25 and 27. An inductance is inserted in the generator circuit to keep the current constant—an inductance being a coil which acts with reference to the current very much like a flywheel does for an engine, keeping the speed thereof constant. A resonant circuit is also connected to the electrodes in shunt with the generator circuit and comprises an inductance (electrical inertia) and a condenser or capacity (electrical tension); these elements are analogous to a tuned string that has mass and tension. A circuit that has inductance and capacity tends to oscillate, as it is a tuned or resonant circuit.

When direct current voltage is applied to the electrodes an arc will burn between them if the arc is struck in the proper way. The property of the arc which makes it available as a transmitter lies in the fact that as the voltage across the arc is increased the current through the arc decreases, and *vice versa*. In a metal conductor the current and voltage vary directly relatively to each other and not inversely as in the arc. An arc that has this property is said to have a "falling characteristic" or negative resistance.

The arc is started by striking the electrodes together and then separating them. This heats the electrodes and they get red hot or even white hot. The electric field between the electrodes "ionizes" the gas that surrounds them, making it conductive. These "ions" are charged molecules which carry the current. The presence of the ions between the electrodes accounts for the "falling characteristic" of the arc.

The action of a converter is about as follows: When the condenser circuit is connected in shunt with the electrodes the condenser charges in a positive direction, storing up a part of the current and diverting part of it from the arc. The decrease of arc current results in an increased potential difference at the arc electrodes, which forces more current into the condenser until it has about all it can hold. As the condenser nears its maximum charge, less and less current flows into it. This means that the arc current is increasing and the arc potential difference is decreasing. The condenser now discharges by reason of the release, so to speak, of the applying potential. The condenser as it becomes charged is put under a strain or stress just like a spring when it is compressed and it acts like a spring when it is released.

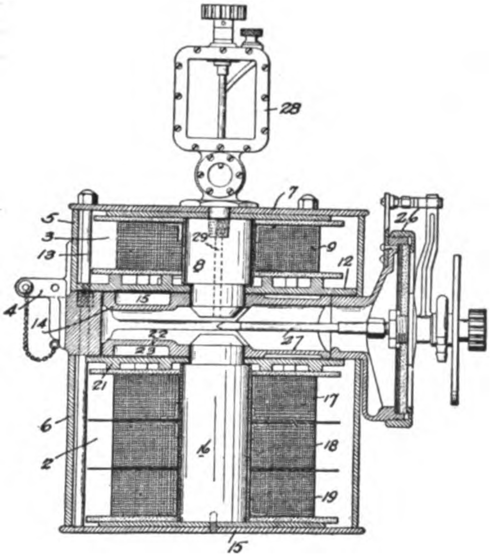


FIGURE 1

Showing the construction of the arc chamber and method of striking and steadying the arc.

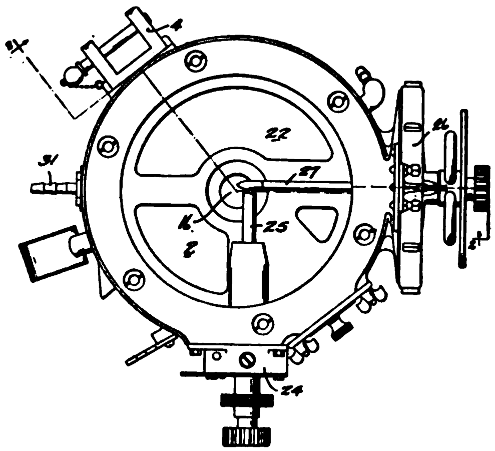


FIGURE 2
Another interior view of the arc chamber, showing the two arc electrodes at right angles to each other.

The inductance in the shunt circuit now acts to keep this discharging current going and the condenser recharges, but in a negative direction. As the recharging is completed the arc current decreases, causing a rise of arc voltage which tends to charge the condenser in the positive direction and the condenser again discharges from the negative direction. This released current further decreases the arc current and accentuates the charging of the condenser in the positive direction. Hence the current oscillates in the resonant shunt circuit first in one direction and then in the opposite direction—the arc acting like a valve which moves to direct the current first into one end of the shunt circuit and then into the other. These oscillations set up in the resonant circuit are transferred to the antenna circuit in any well-known manner where electromagnetic waves are radiated into space:

The maximum discharging current from the condenser which tends to neutralize the arc current may be large enough to extinguish the arc. In order to make the arc more sensitive to voltage changes, means are provided to deionize the arc gap when the arc is extinguished, thus making it non-conducting and requiring a longer period to build the current up to full strength. A strong magnetic field or "magnetic blow-out" will remove these ions, drawing them to one side away from the gap. Cooling means and the use in the arc chamber of hydrogen or a hydrocarbon gas also assist in deionizing the gap. It is seen that the Beal apparatus contains these features, which are due broadly to Poulsen.

The magnetic field set up between the ends of the magnet is transverse to the flow of ions across the arc, and this field draws the arc flame to one side of the electrodes, making its path longer. The principle involved here is the same as that which causes a motor armature that carries a current to rotate in a magnetic field. When the condenser discharges it is easier to extinguish the arc with the arc flame drawn to one side. After the arc is extinguished, ions of course are also removed by means of the magnet; these ions are drawn to one side away from the electrodes just as a pin is attracted by a magnet.

The magnets used in high-powered arc sets are large and powerful. For instance, the magnets of a 500-K.W. set may weigh as much as 65 tons.

Cooling of the electrodes also greatly aids in the rapid deionization of the chamber. For this reason the positive electrode is usually made of copper (which is a good heat conductor) and cold water is circulated around them.

Hydrogen and hydrocarbon gases also assist deionization because these gases, being very light, diffuse rapidly into the outside space and carry the ions with them. A hydrogen atmosphere also has high heat conductivity and also prevents the oxidation of the electrodes.

The object of the invention of Patent 1,410,730 is to provide a generator or converter that has an efficient magnetic circuit and a readily accessible arc chamber. The inventor claims that in his magnetic circuit the leakage flux is reduced to a minimum. This is of decided advantage on ship board where such magnetic leakage would produce a deleterious effect upon the ship's compass. The magnetic circuit, including shells 5 and 6, end plates 7 and 15 and cores 8 and 16 has a minimum "reluctance" or magnetic resistance. Leakage flux is also reduced by placing the magnet coils on opposite sides of the chamber, one in each segment. By reducing the length of the magnetic path the coils may be placed close together and the arc chamber made very shallow. By building the converter in segments, as shown, access may be had to the narrow arc chamber by lifting the upper segment.

Arc transmitters are especially adapted for high-powered long-distance work at long wavelengths, but the high cost has prevented extensive study by scientists and engineers except when installed for commercial use.

The most powerful radio station in the world (that at Bordeaux, France, constructed by the United States Navy) is equipped with a 1,000-K.W. arc set. The most powerful station in the United States (that at Annapolis, Maryland) is equipped with a 500-K.W. arc transmitter. Most of the capital battleships and other ships of our Navy have arc transmitters.

It should be a matter of only a few years when arc transmitters will be used in radio telephony as well as in radio telegraphy. Before they can be used extensively in broadcasting the generation of objectionable harmonics, secondary waves that have frequencies which are multiples of the fundamental frequency, and intermediate frequencies called "mush," must be eliminated. These secondary frequencies cause interference.

A Crystal Detector

Patent No. 1,410,793; A. Bonnefont, Paris, France.

ONE of the important elements of a receiving set is a "detector"—a name which is inappropriate because such an element does not detect but merely makes possible the detection of electro-magnetic waves or radio signals. Detectors convert high frequency currents or voltages into forms capable of operating an indicating device (such as the telephone head piece), so that the signal may be heard.

Such detectors are of various forms and kinds, such as the electrolytic, audion (the vacuum tube) and crystal detectors.

Crystal detectors and detector tubes are, of course, familiar to all who are interested in radio.

Certain crystals have the curious property of being unidirectionally conductive; that is, they conduct currents that flow in one direction through them and do not conduct those that flow in the opposite direction. Such a crystal acts like a "valve" which allows water to flow in one direction but not in the opposite direction. As examples of such crystals we may mention galena (lead sulphide), silicon (a chemical element) and certain other sulphides. Why these crystals have this curious property is not clear unless they were especially designed for radio reception. Possibly the future study of "electrons," those negatively charged ultimate particles of the atom of which we now hear so much, will result in the discovery

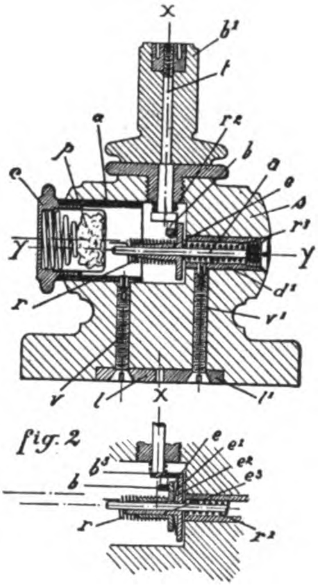


FIGURE 3

A crystal mounting which protects the crystal from dust and grease, though at the same time affording ease of adjustment.

of sufficient facts to formulate a plausible theory of the cause of this phenomenon. Most of these crystals are chemical compounds that comprise a combination of a metal atom (a conductor) and a sulphur atom (one of our best insulators). It is possible that the atoms of each of these crystals and, in turn, the electrons which comprise each atom are so arranged and related as to cause the crystal to be strongly metallic in one direction and therefore conductive and strongly sulphurish in the opposite direction and hence non-conducting—the electrons acting very much like those in the electron tube or detector which is now so important in radio communication.

Another property of such a crystal, which must be considered a defect, is that all points on the crystal are not sensitive. We must feel around on the crystal to find or select a spot that has such unidirectional conductivity. The case is much like that of our bodies, portions of which are insensitive to pin pricks.

On account of these properties of crystal detectors they have been used for years to rectify alternating currents or high frequency radio oscillations; that is, to change them into direct pulsating currents of a form capable of actuating a diaphragm of a telephone receiver at audio frequency so that the signal can be heard.

A. Bonnefont has devised an interesting improvement in crystal detectors for locating the sensitive spots while the crystal is enclosed so that dust and grease cannot touch it and which also allows variation of the pressure of the metal point on the crystal. (See Figure 3.)

The casing *s* encloses the crystal *p*, which is held in a rotatable thimble or support *c* by means of a spring. A guide rod *a* is secured in casing *s* opposite the crystal *p*, but on an axis *Y-Y*, which is eccentric with the axis of the crystal. A flanged sleeve *e* is slidably mounted on rod *a*. A coiled spring *r* is mounted on the sleeve *e* and has an eccentric free end adapted to contact selectively with the crystal. A spring *r'* upon rod *a* tends to force sleeve *a* with its spring *r* toward crystal *p*. The free end of spring *r* may be rotated around the axis *Y-Y*, to selectively engage different points on the crystal, by means of an actuating knob *b'* secured to a shaft *t* journaled in casing *s* and extending at its inner end into the casing. The inner end of the shaft *t* is provided with an eccentrically arranged stub *b*, engaging the flange of sleeve *e*. When shaft *t* is rotated, stud *b* will rotate sleeve *e* and spring *r* to position the contact end of the spring at different points on the crystal.

It should be noticed that this rotation will also move the sleeve axially against the pressure of spring *r'* to vary the pressure of the point *r* on the crystal. By rotating the thimble or plug *c* that carries the crystal, the latter is rotated to present a new circle of point *s* capable of being engaged by the contact end of spring *r*. The electrical connections are made at opposite sides of the crystal through the screws and plates *v* 1 and *v'* 1' and sleeves *d d'* which are mounted in the insulating casing *s*. The spring *r* 2 is to frictionally maintain shaft *t* in any desired position of adjustment.

Because the rod *a* is eccentric to the axis of crystal *p* and by reason of the eccentric arrangement of the exploring point *r* with reference to rod *a*, either crystal or point *r* may be rotated to present new and different sensitive points for contact, without exposing the exploring point *r* or crystal to the air, dust or hand. The crystal detector is easily adjusted by the eccentric stud *b* not only to rotate the exploring point *r* but also to move it axially.

When a detector of this character is used in a radio receiver it changes the alternating current or oscillations set up therein into a direct pulsatory current capable of actuating the telephone diaphragm if the pulsations are of audio frequency as is the case in the reception of modulated radio frequency continuous waves. The new device helps in this function by keeping the crystal clean.

ITEMS *of general interest that you ought to know; bits of information of practical usefulness to every radio amateur.*

Fewer and Better Broadcasting Stations Needed

THE demand for broadcasting licenses is growing apace; already more than 360 licenses have been granted. Every State in the Union is represented in this number except five. Sooner or later the confusion that must inevitably result from what is developing into an overcrowded condition must lead to some restriction that is not at present within the authority of the Department of Commerce to impose. At present any applicant can get a broadcasting license if he complies with the legal requirements. The result is that in certain centers there are as many as fifteen broadcasting stations, all operating on the same wavelength. Some of them are inadequately equipped for broadcasting entertainment, and most of them have but a limited range.

The bill now before Congress will give authority to the Secretary of Commerce to use wider powers of discrimination in the issuance of broadcasting licenses.

A Scheme for Paying Artists for Broadcasting

WHO will pay for the broadcasting programs? The question has been seriously agitating the radio world for many months; sooner or later it must be answered in some way by some one. Many solutions of the problem are being put forward; one of the latest schemes has been projected by an organization created in New Orleans that calls itself "The National Co-Operative Radio Society," the purpose of which is not financial gain, but "to effect a community of interest among parties who are now interested or may hereafter become interested in radio telephony" and to establish the whole broadcasting business upon a sound economic basis.

Briefly, the society aims to build or lease and to operate a chain of broadcasting stations, each of about 1000 miles radius, throughout the country. It proposes to divide the country into zones and to relay the program from zone to zone. It also proposes to pay for the talent it employs and to establish a daily program lasting from 10 o'clock in the morning to 10 o'clock at night. The costs of all this will be borne by the members of this society, who will be assessed sums not to exceed $12.00 a year. The plan is said to have the backing of a number of owners of receiving sets as well as of numerous manufacturers, jobbers and dealers. According to the announcement, the membership is open:

1. To any individual or firm who may be interested in the welfare of radio telephony.
2. To any individual, or firm, owning a receiving set, or who may contemplate owning a receiving set.
3. To any corporation, manufacturer, distributor, jobber, or dealer in radio apparatus or complete receiving sets, or kindred lines.

(These are urged to take as many memberships as may be warranted by the pecuniary benefits to accrue from increased sales, due to De Luxe Program properly broadcasted by the National Society.)

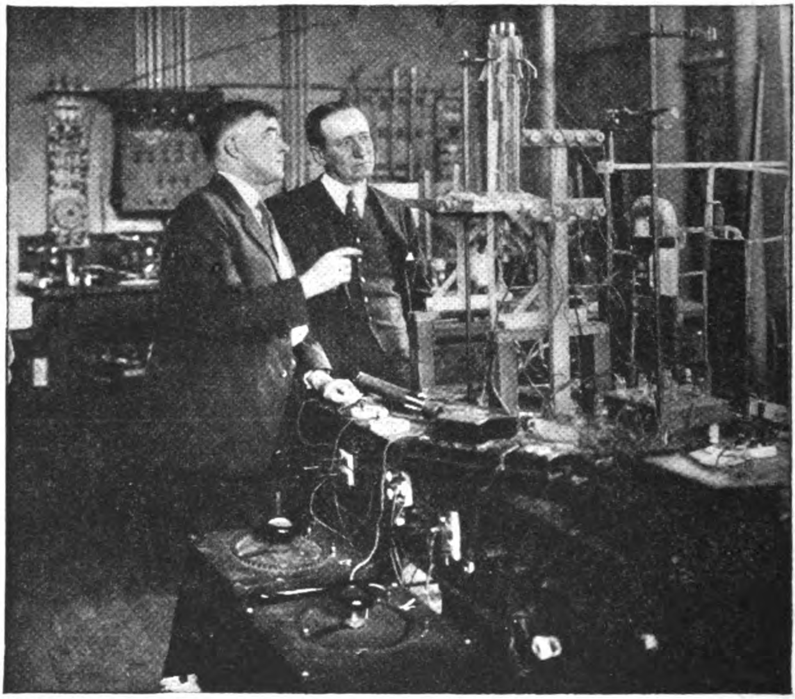
4. To any radio engineer, or other individual holding certificate, or permission to broadcast or receive.

5. Honorary memberships may be extended when considered advisable by the National Committee on Memberships.

Radio Opens the Mines

THE mining industry of the country in certain quarters is being affected by the widespread extension of the use of the radio telephone. The supplying of crystals of certain ores has become a small industry in itself.

These mineral crystals are used as detectors that transform the pulsating electrical vibrations received by the antenna into those that can be converted into sound waves by the telephone receiver. The bright cubical crystals of galena, a compound of sulphur and lead, is a favorite detector, and pyrite or chalcopyrite, the first combination in chemical form of sulphur and iron, and the other, sulphur, iron and copper, are also used. Not all crystals of these minerals will detect radio messages with clearness. A demand for suitable crystals has caused the mining operators to search over their ores and to submit perfect crystals for the radio manufacturers. Meanwhile there is a constant search for a dependable supply of the best material.



Kadel & Herbert

DR. LANGMUIR EXPLAINS TO MARCONI THE "MESSAGE FROM MARS"

During the Italian scientist's visit to the laboratories of the General Electric Company the assistant director, Dr. Irving Langmuir, shed some light on the unexplained "signals of 150,000 meter wavelength" which Marconi is said to have recorded. "During the time Marconi was reported to have received this long wavelength message, engineers of this company were experimenting with carrier current on the Schenectady-Saratoga trolley line," Dr. Langmuir said. "As these tests were made on a trolley wire forty miles long, thus making an antenna of that length, I had thought that possibly our high voltage tests on this wire had created such a wavelength. But I talked with Marconi, and he tells me that he never received any such signals as reported in the newspapers." Marconi is shown above talking to Dr. Langmuir.

Kadel & Herbert

GERMANY'S FIRST BROADCASTING STATION

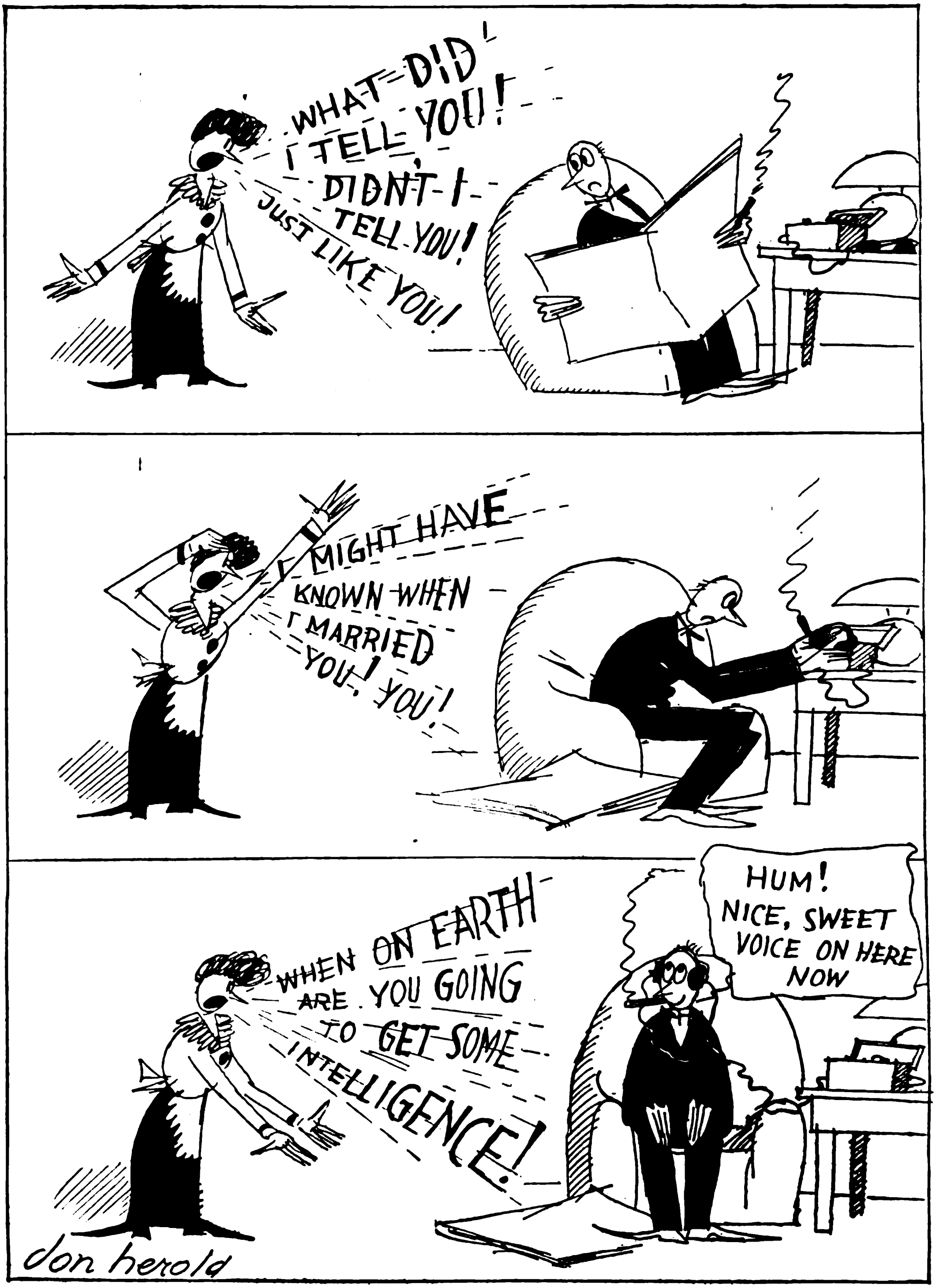
This unpretentious scene reveals Berlin's first and only radio broadcasting headquarters; it furnishes impressive evidence of the progress that has been made in radio in the United States. American amateurs have been entertaining their friends for more than ten years with such concerts as pictured above. The picture contrasts strikingly with the views of modern American stations.

Few amateur radio enthusiasts, probably, are aware that there is one material in the many pieces of apparatus that cannot be replaced by any substitute that scientists have yet discovered. This material is mica—a mineral substance found in nature that has unique dielectric properties; that is, it resists the passage of electricity even at remarkably high voltages. It seems unbelievable that thin sheets of this transparent material, only a few thousandths of an inch thick, can successfully perform this necessary function.

The market for copper, which has been very poor, has also felt the effects of increased demand due to the extensive use of copper wire and brass in the manufacture of radio outfits. It is estimated that the average radio receiving set requires at least two pounds of copper in its manufacture.

Swimming Contests by Radio

DURING the coming winter radio amateurs expect to lengthen their radio relay traffic lines to all parts of the world. For several years messages each night have been flashed from amateur station to amateur station in all parts of this country and Canada. With the increased use and efficiency of continuous wave telegraphy and the interest and energy that radio amateurs in China, Japan, Hawaii and European countries are showing, officials of the American Radio Relay League believe that when the summer's static storms and interfer-


WHAT DID I TELL YOU!
DIDN'T I TELL YOU!
JUST LIKE YOU!
I MIGHT HAVE KNOWN WHEN I MARRIED YOU! YOU!
WHEN ON EARTH ARE YOU GOING TO GET SOME INTELLIGENCE!
HUM! NICE, SWEET VOICE ON HERE NOW
don herold

The Demon Illustrator, Don Herold, has again had his imagination stirred by the radio and its possibilities in the home—as seen from the Mere Man's point of view.

ing vacation trips are over, duplications of amateur short wavelength spanning of the Atlantic which was accomplished in February may be nearly a nightly occurrence. The development of the new Armstrong circuit (described on page 18 of this issue) has brought the realization of world-wide amateur radio closer.

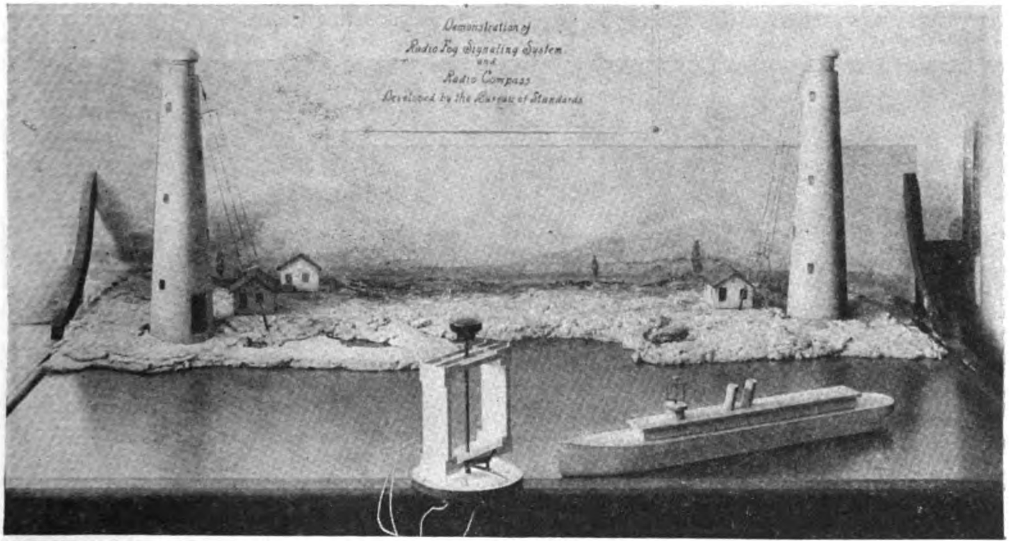
The thrill of long distance transmission alone does not urge the amateurs on, however. They hope to put their carefully worked-out radio relays to practical use. The American Radio Relay League has just been approached by a Buffalo athletic organization with the hope that a long distance radio swimming meet with a Hawaiian swimming club could be arranged. All results—times and events both ways—would be reported by amateur radio. This scheme cannot be worked out in warm weather because of the poor sending conditions of summer and the fact that many of the relay operators are taking their vacations. But a water contest by radio is among the possibilities for the fall.

A Jules Verne Dream Come True

THE individual whose father was astonished when Dr. Bell announced that he could talk over a wire has experienced somewhat the same feeling as his parent during the past year's expansion of radio. But he has more surprises in store for him.

Armstrong, already famous for his regenerative circuit, calmly announces that he can make his radio signals 10,000 times stronger by making a simple addition to the appartus simply by rearranging the wires. The General Electric has made a new tube that will replace the large alternator machines that are used in large sending stations. A new wire antenna system is being perfected. Marconi predicts a future for extremely short waves. Radio frequency amplification is being refined and improved.

It is becoming increasingly hard to predict just where our receiving range will end and the distance which even a small amount of power will transmit. The amateur is having visions of a future of which the world has not dreamed.


Demonstration of
Radio Fog Signaling System
and
Radio Compass
Developed by the Bureau of Standards

Bureau of Standards

A WORKING MODEL OF THE RADIO COMPASS

To demonstrate just how the radio fog-signaling device works, the Bureau of Standards has devised this miniature scene. The coil of the radio compass rotates on its axis as the radio signal from the lighthouse decreases in intensity, until the minimum point is found—at which point the indicator points to the lighthouse. Each lighthouse is provided with a buzzer that operates by clockwork.

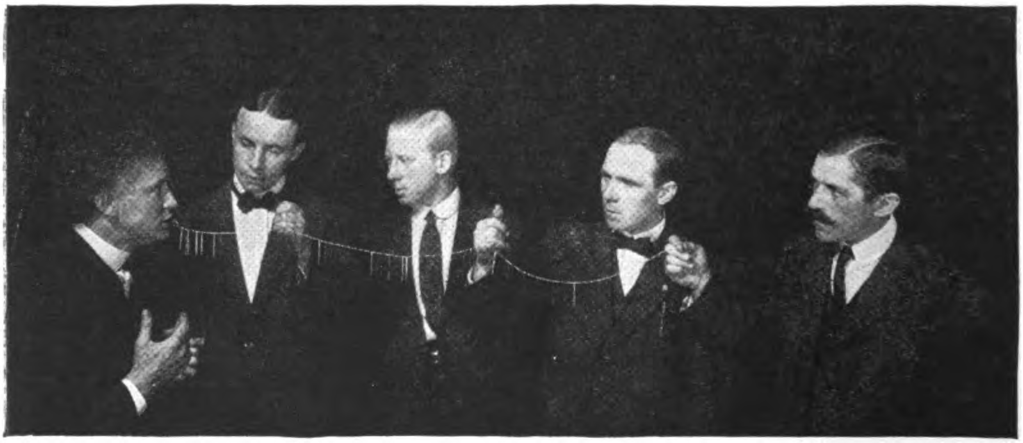
The Summer Slump as a Boon to the Radio Novice

THE summer slump in the radio business came according to schedule. By the time these lines are published the inevitable fall revival should be well started. The experience has not been unprofitable to the trade; indeed, one well-known manufacturer of radio apparatus has referred to the slump as a "boon," and explains his attitude thus:

"Dealers are beginning to realize the fact that they cannot afford to carry a large and heterogeneous lot of odds and ends in radio apparatus in the hopes that they will be able to dispose of it. They are learning that hysterical overstocking of apparatus in an effort to meet the spasmodic demand of radio faddists is not going to prove profitable in the long run, and that dependable apparatus, bought to meet the varying radio conditions, is more to be relied upon than unknown apparatus that looks good in the catalog and is merely an ornament upon the shelves.

"Manufacturers, too, are learning their lesson from this slump. They are realizing that the time of order taking is past and that the time of order getting is here; that in order to sell radio apparatus, they must give good value, serviceable merchandise, attractive prices and real service and dealer co-operation. Competition is keen and hitherto there has been too little of this healthy form of competition. Now that dealers find they must discriminate between the good and the bad in radio apparatus, they are learning to serve themselves and their customers better, in that they are buying and selling apparatus they know to be good. As a result the entire industry must improve; that is why I believe the slump in radio, which brought the industry to its senses, is a good thing."

All of which reacts to the interest of the radio novice in that it tends to remove from his reach some of the junk that has been foisted upon the market by inexperienced or unscrupulous manufacturers and sold by equally if not still more inexperienced or unscrupulous dealers. But the time has not yet come when the uninformed layman can enter a shop and buy his radio supplies with the same assurance with which the salesman represents them.



HOUDINI "SAYS A MOUTHFUL"—OF THREADED NEEDLES

No man in the country knows more about the tricks of the professional magicians than Harry Houdini—or just "Houdini" as he prefers to be called. In this picture he is performing his famous Yogi trick of swallowing a package of needles and some thread and extracting the needles threaded—and doing it before a committee appointed to find out how he does it. For the next number of POPULAR RADIO *Houdini has written a startling article that exposes the tricks of the fraudulent "spirit mediums" who have used radio for years for getting money from their credulous public.*

HINTS FOR AMATEURS

BE sure to turn down the rheostats before relighting your tubes as the battery may "pick up" and produce too high a voltage for the tubes.

* * *

GAS pipes are usually insulated from the ground with special fibre joints and therefore do not make such a good ground as the water pipes.

* * *

IF you use a tungar rectifier to charge your batteries, remember never to turn on the filaments of the tubes while charging, as you will probably burn out the tubes with the higher voltage.

* * *

Do not try to mount your crystals in solder. The heat needed to melt the solder will destroy the crystal's sensitiveness. Use Woods metal, which has a very low melting point.

* * *

Do not clean any part of the radio apparatus with soap and water, as the moisture will ruin the electrical properties of the instruments. Use a light furniture oil and rub dry.

* * *

YOU can convert one of your receiver telephones into a loud speaker by placing it against the small end of an ordinary megaphone. This will cause the sounds to be acoustically amplified so that they can be heard all over the room.

* * *

THE use of stranded wire for the transmitting antenna is recommended as the high frequency currents that are used in radio communication travel on the surface of the wires, and the stranded wires naturally have the larger surface.

* * *

Do not try to use the electric light wires in your house for a ground; all you will hear if you do will be a continuous humming sound in the telephones. If you should choose the wrong side of the line you will get a shock or blow the fuses.

* * *

THE higher the voltage you put on the plate of the last step of amplification used in connection with your magnavox loud-speaker, the louder will be the signals. Amplifying tubes now on the market will stand about 150 volts without any trouble. This requires about 6 or 7 "B" batteries.

* * *

Do not use unglazed porcelain cleats for the insulators of your antenna. In rainy weather they will absorb a large quantity of moisture and the weak electrical currents induced in the antenna will leak through the insulators to the ground instead of passing through the receiver.

* * *

WHEN testing your "B" batteries, do not touch the ends of the two wires together (as many amateurs do) to see if there is any "juice" left in them. This short-circuits the battery, and if it should be in good condition, this form of test will reduce its life greatly. Use a voltmeter.

* * *

USE the same kind of wire for stringing up your insulators that you use for the antenna itself. Rope will stretch and shrink with the changes of weather and will cause the antenna to sag and tighten up. This strain may cause the wires or the rope to give way.

* * *

A SHORT circuit in a variable condenser can easily be detected by connecting a buzzer and a battery in series with the condenser. If upon turning the knob of the condenser the plates do touch, the buzzer will buzz. A little spark will be seen where the plates touch and repairs can then be made.

* * *

FOR insulating a receiving antenna, ordinary porcelain cleats that can be obtained in almost any electrical supply store will be satisfactory. The dimensions of these cleats are approximately 3½ inches in length, ¾ inch in width, and ½ inch thick. The cleats have a hole in each end through which the wires may be readily fastened.

* * *

WHEN running your lead-in down the side of the house, keep it as far away from the building walls as possible. The walls of the building will absorb energy from your antenna if it is run too close. When you fasten your antenna to a tree, place your insulator at least twelve feet from the branches so that the absorption by the tree will be reduced to a minimum.

* * *

A LOOP antenna can be used indoors without any connection outside the house or without any connection to the ground. It cannot be used without some form of amplifier, however, as the amount of current induced in a loop antenna is small and should have at least two steps of either radio or audio frequency amplification to increase the feeble currents to sufficient strength to make signals that are readily audible.

* * *

To get the best results from your audion detector, use a grid leak. A grid leak is a resistance of 1,000,000 to 2,000,000 ohms that is connected in shunt to the grid condenser or between the grid and the negative lead of the filament. Its purpose is to allow the negative charges that accumulate on the grid during operation, to leak off so that the tube will not become inoperative on account of the grid becoming too negative.

* * *

IF you operate a sending station, do not start to send or test it out without first listening in and making sure that you will not cause interference by doing so. Give the warning signal as prescribed by the regulations of the Department of Commerce; if anybody else is working and you cause them interference, they will ask you to "stand by" for a minute and then you may have your own turn on the ether. Courtesy is the best policy, after all, in the ether as well as elsewhere.

* * *

To find out which is the positive and which is the negative pole of any kind of a battery is a puzzling problem—until you know how. The simplest way to do this is to obtain a glass (not metal) dish filled with water; in it place two wires which have been connected to the terminals of the battery. When the two wires are placed under the surface of the water, small bubbles will soon be seen to collect around the end of one of the wires. This wire is the negative wire and the little bubbles are hydrogen gas bubbles.

* * *

THE difference between a "hard" and "soft" vacuum tube lies in the degree of vacuum that the tube has been pumped to, or the rarity of the gases which the tube contains. A hard tube has been exhausted to a high degree of vacuum; a soft tube, on the other hand, has a little gas left in it. The hard tubes are used as amplifiers because they will stand a higher "B" battery and are less critical; the soft tubes are used for detectors because they are more critical and have a higher plate current with a given plate voltage. Soft tubes are not good amplifiers because they are apt to ionize when large currents are passed through them.

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Popular Radio

OCTOBER 1922

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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VOLUME II OCTOBER, 1922 NUMBER 2

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

DR. LEE DE FOREST BROADCASTS HIS OPINION OF *POPULAR RADIO*

It comes very close to my idea
of what a popular, semi-technical
radio magazine should be.

Lee de Forest.

U. S. Signal Corps

¶ *"RADIO will bring to the people of this country the intellectual background which heretofore only the rich could afford. Yet the work of the radio engineer as an educator has only just begun. Soon we will be measuring culture by watts."*

—GEORGE O. SQUIER

Popular Radio

VOLUME II OCTOBER, 1922 NUMBER 2

What Will Take *the* Place *of* TODAY'S BROADCASTING?

One of the Possible Solutions of the Most Vital Problem Before the Radio Fan Today, as Proposed by——

MAJOR-GENERAL GEORGE O. SQUIER

BROADCASTING was impossible without an audience. As soon as an audience was provided, broadcasting was possible, and it began. The audience was provided by the boy amateurs—by the youthful tinkerers who for four or five years had been playing with coils and sparks and antennæ—who had been trying, night after night, to get through a few dots and dashes to the other boy enthusiast in the next block. This amateur audience was ready and waiting for the broadcaster; its existence is what made broadcasting such an instantaneous success.

The present conditions in radio are training a larger audience. Father and mother have joined the boys around the radio set. It has been estimated that about five million people listen in every evening on the broadcast programs.

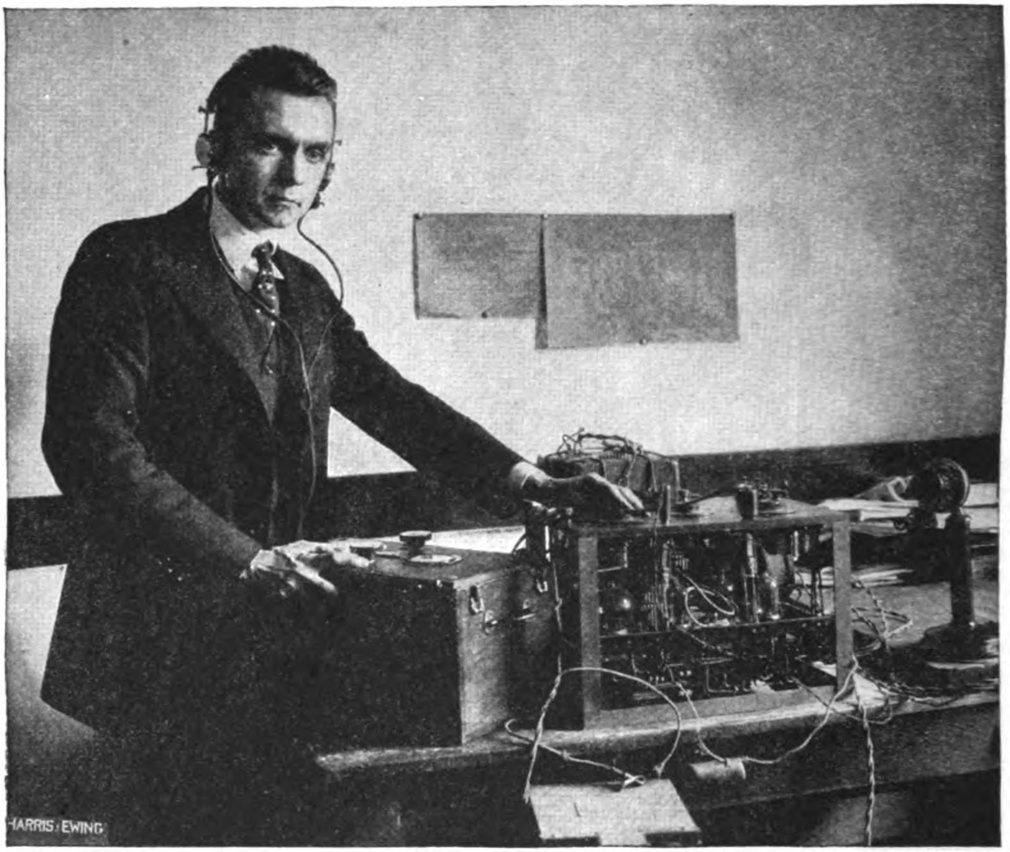
What are we going to do with this audience?

Amateur radio prepared the audience for broadcasting. Broadcasting is now preparing another audience, a larger one—for what?

Some people seem to think that broadcasting is a fad; they believe that people will return for entertainment to the phonograph, to the motion picture and to the spoken drama. They believe, so they say, that the radiophone is a temporary craze.

I do not think so. What happened to amateur radio? In one sense it passed, but it passed into a far bigger thing. It passed into radio broadcasting. Radio broadcasting as now conducted may pass in its turn. I imagine that it will. But it will pass into something else, into something bigger and better, something more useful to men and to society.

The basis of a democracy is education. Unless we can properly educate our children and our immigrants, the American idea of government will fail. And no one can be educated solely in school. Far more important is the atmosphere at home; the background, good, bad or in-



Harris & Ewing

A RADIO RECEIVER THAT USES A TELEPHONE WIRE AS AN AERIAL

The scheme for transmitting radio programs to subscribers only is brought within the realms of possibility by this super-phone, or "line radio duplex transmitter and receiver," developed by R. D. Duncan, Jr., head of the research laboratory of the Signal Corps. The device may be attached to the ordinary desk telephone.

different, against which the family life goes on. Is this a background of good books, good music, intelligent conversation? Or is it a background of crime news from the papers and of neighborhood gossip?

Think of what radio can do to help this situation. Radio can go a long way toward supplying whatever kind of home background the country needs its citizens to have. Inspiring music, the uplifting words of great teachers, the everlasting principles of our political fathers, can be poured every day and hour into the waiting ears of all our citizens—poured in to form the minds of children, to revive the courage of the common man, to instruct and set right the newcomer from foreign lands.

The country can *make* us listen, all of us. It will be so easy to listen that we cannot escape. We will not want to escape. Comfortably, each one of us beside his own library table, in his favorite chair, without cost or exertion or the annoyance of dressing up, there will come to our ears at the turn of a little knob the best thought and the finest artistry of all the world.

And to our children's ears no less. To our children radio will bring the intellectual background which only the very rich have been able to provide, a background of exquisite sound. The poorest nursery can have its interior decoration of music, its aural furnishing, as now we put bright pictures on its walls. For nurseries and for all the house we can replace mere noise with controlled harmony. Already the music of the Marine Band, which all of us help to support, is not confined to Washington; it is broadcast regularly. Already any little town in Maryland or Virginia can have its radio set and its loud-speakers—can gather in the evening at the band stand for its own concert by this world-famous organization. Yet this is only a beginning of the work of the radio engineer as an educator. Soon we will be measuring culture by watts.

And as to the more permanent social influences of such daily aural backgrounds, what might be, for instance, the influence on business morality if fifty people heard each day the simple and persuasive eloquence of the Sermon on the Mount?

This is exactly what radio can do. The radio engineer will be, I firmly believe, the prophet and the architect of a new social era, the inventor of the first successful system for the education of all the people.

For this to come about we need only two things:

First: we must simplify the radio receiver, and

Second: we must avoid, somehow, the present confusion of broadcast messages, the overcrowding of the ether.

Both of these improvements can be made, and can be made easily.

The Bureau of Standards has produced a vacuum tube equipment which works on an ordinary electric lighting circuit. This may eliminate from the radio set the present type of battery. The principle of the resonance coil, developed in the laboratories of the U. S. Signal Corps, not only accomplishes the virtual elimination of static but reduces the laborious and uncertain tuning to a single operation, to the mere sliding of a contact arm along a coil. These two advances remove the main reasons why the present-day radio set is overcomplicated and is too hard to manage and adjust. The next step is get rid of the aerial. This can be done easily by using the electric light wire or the telephone wire.

Every house has two avenues through which the outside world comes into it, the electric light wire and the telephone wire. Already the massed network of these wiring systems is prodigious in extent. The United States is one vast grid of wire. If some jinn could dissolve away all the brick and iron and concrete of the buildings of lower New York, leaving only the electric light wires, the form of the buildings would be as visible as before. Each floor, each wall, each room would be represented by a cage of intercrossing wires. The telephone wires make another system equally complete and complex, in fact, since the telephone system is continually changing its configuration as its calls are plugged in and out.

Each of these vast networks of wire is really a cage aerial, a three-dimension antennæ system. The electric light wires and the telephone wires of New York pulsate every instant with all the potential changes due to every wireless message passing through the ether. Each Marconigram from Europe is recorded, pulse by pulse, on these two independent networks of wire.

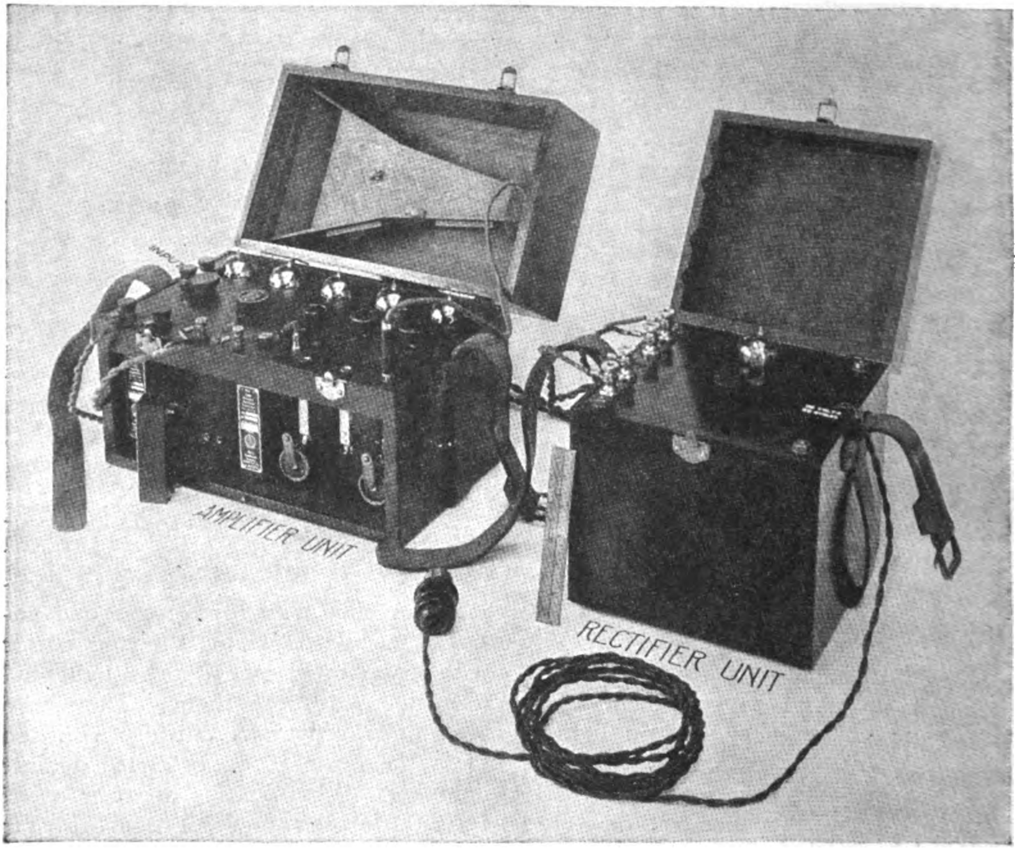
Both of these networks come into your house. Why not use them to get your radio signals? What is the use of spoiling your roof with troublesome and unsightly aerials, or filling up your parlor with complicated loops? The light and telephone wires are there. They have been laboriously and skilfully insulated from the ground and protected against lightning. Why do this all over again for a little private wire system of your own? Why not forget about your own private aerial and use those already available to you?

With proper apparatus there is no danger to or from the wires, no interference with their use for light or telephone service. All the music and speech which is pulsating through the ether, all this wonderful potential background of education, comes into your house anyway through the two avenues, namely, the light wires and the telephone wires. The radio set of the future—I believe, of the very near future—will be some simple apparatus which you can plug into any light socket, or connect to any telephone. It will be something which you can buy in any drug store. It will be something dependable and standard, which you do not have to "set up" or "install."

When we get this we can begin to count on developing an intelligent, well-meaning and broadminded public opinion.

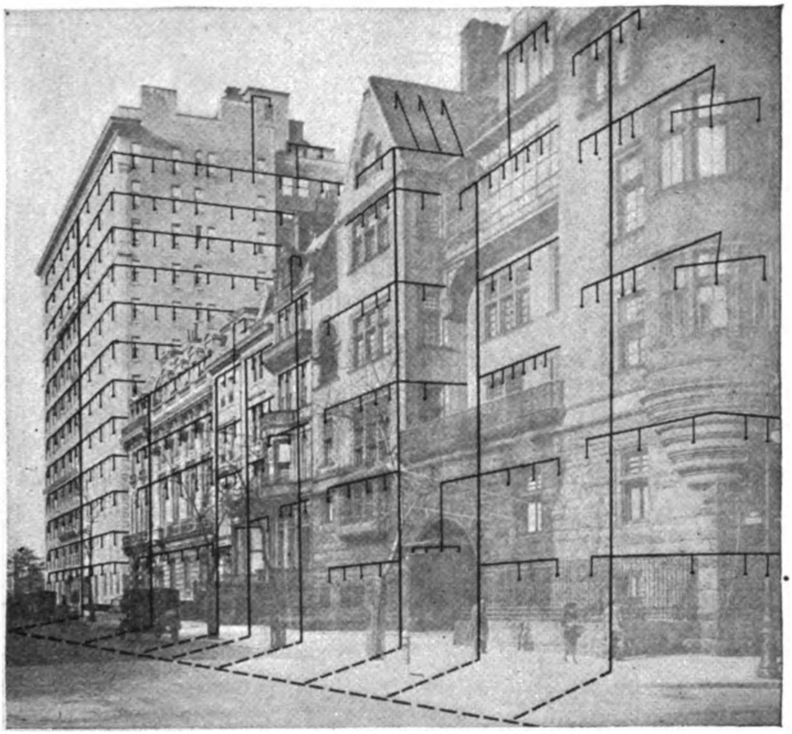
The difficulty of an overcrowded ether can be met with equal ease. The work of the Signal Corps on carrier current radio, or "wired wireless," is well known. By this system radio waves can be sent over ordinary wires. This is already in use for telephone service over power or telegraph wires and for superposing two or more telephone conversations on the same wire.

By the use of this system anything could be broadcast over the electric light wires of a city. Items of local interest only need not be loaded on the ether for everybody to hear; the local



YOU CAN "PLUG IN" THIS RECEIVING SET ON YOUR ELECTRIC LIGHT CIRCUIT

That the ordinary electric light wiring can serve as aerials for "wired wireless" reception has been demonstrated by this receiving set devised by the Bureau of Standards under General Squier's direction. It is possible that the electric light corporations of the future will furnish the broadcast service—to customers only.



From a drawing made for POPULAR RADIO

THE WIRE SKELETON OF A CITY BLOCK

The possibilities of bringing radio programs into buildings by way of the telephone and light circuits is illustrated by this diagram. If all the brick and iron of our city structures were dissolved away, the forms of the buildings would still be indicated by the wiring.

wire systems will carry the load instead.

For instance, department store advertising is of real interest to people who live near the store. It is not of interest to listeners a thousand miles away. It will be necessary to distinguish between local news and general news; between local civic matters and general governmental ones. The use of the local wire systems for broadcasting by radio permits one to make this distinction effective.

Like the use of the electric light wires as aerials, this broadcasting over them will interfere in no way with their proper purpose of carrying current. Several power companies are understood to be experimenting already with the idea of furnishing their customers with broadcast entertainment just as they now furnish them with electric light.

These, then, are the three developments in radio which I can see near at hand.

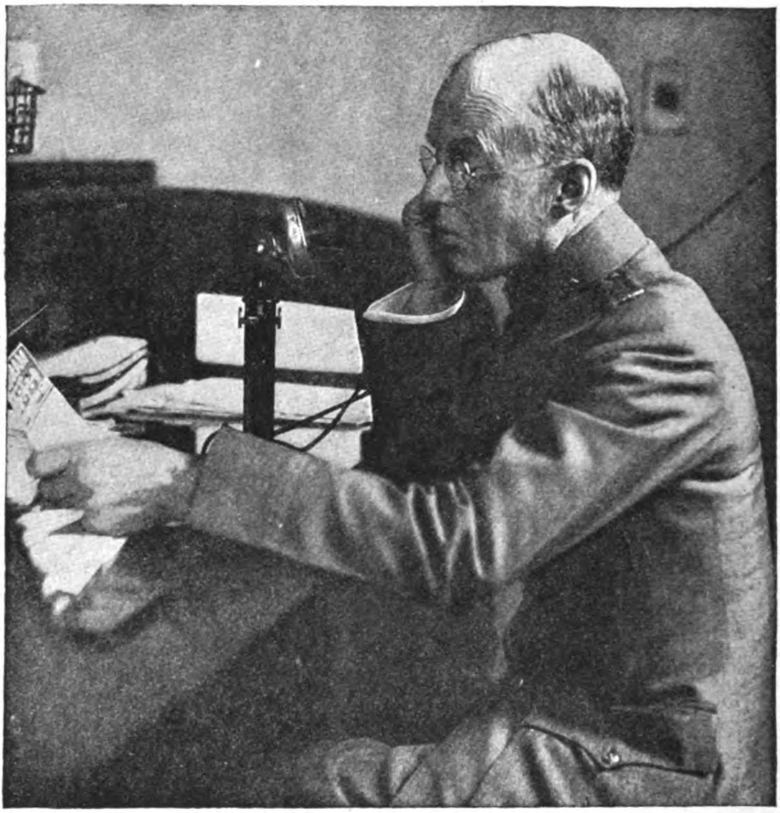
First: the simplification and standardization of the receiving set.

Second: the use of light wires and the telephone wires as aerials for everybody.

Third: the use of local power systems for local broadcasting.

Through these three developments there will come to every man's home a stream of the best things of the world—a stream to be tapped and enjoyed when he wishes, to be shut off by the simple turn of a switch when he does not; a stream out of which he may select what pleases his fancy or meets his changing needs.

Thus will the radio engineer provide a new cultural background for humanity, a new and powerful agency for the advancement of mankind.



Pacific & Atlantic

HE ADMINISTERS TO HIS PATIENTS AT SEA FROM A CITY SKY-SCRAPER

Emergency radio calls for medical help from vessels off our coasts are relayed by Uncle Sam's coastal stations to one of three hospitals maintained by the Bureau of Health—the U. S. Marine Hospital in New York, the U. S. Veterans' Hospital in Philadelphia and the U. S. Marine Hospital in San Francisco—from which expert advice is returned. Dr. E. K. Sprague (shown above) is in command of the New York headquarters of this unique service.

"Old Doctor KDKF"

A Remarkable Form of Long-Range Medical Service that Uncle Sam Is Developing to Cure the Sick and Injured on Ships Beyond the Reach of Surgeons

By HOMER CROY

BLOSSOM HEATH, an English cargo ship, stopped at New York, discharged part of its freight and steamed confidently for Panama. It passed through the Canal and started on the long stretch across the Pacific ocean for Hong Kong and the China Coast.

And then one night, abruptly, misfortune laid its heavy hand on the ship.

There was groaning in the quarters of one of the ship's crew. When help came the cook was writhing in pain. For anything to happen to the chief cook on such a long voyage is a catastrophe. The captain was called and in the glory hole, gently rocking to the movement of the ship as it plowed steadily into the tropical night, the captain sought to find out what was the matter. But he was not a man of medicine and the cook could tell him little. All the cook knew was that he was in great misery; he had eaten nothing; taken no wrong medicine. He could not explain it. The captain took his pulse, and found a fever thermometer, but otherwise he was helpless. The pains grew worse. It would be days before port was made, before there could be hope of medical attendance.

And then as he bent over the groaning man in his bunk, with the silent seamen outside in the narrow passageway, an idea came to the captain.

"Send me Sparks," he said. Everyone knew what he meant, for over the seven seas the ship's wireless operator is thus known.

The captain wrote a brief description of the cook's symptoms on a pad and signed it as master of the *Blossom Heath*.

"Call Station KPH, San Francisco, and ask them to tell me what to do."

San Francisco answered the call and a physician of the United States Marine Hospital was brought to the telephone. The captain's message was read to him and the doctor gave his advice—and in just sixteen minutes after the captain's message was sent into the air the doctor's advice was back.

Two days later the cook was well!

Thus had the cook on an English cargo ship in the midst of the Pacific ocean been saved by American radio.

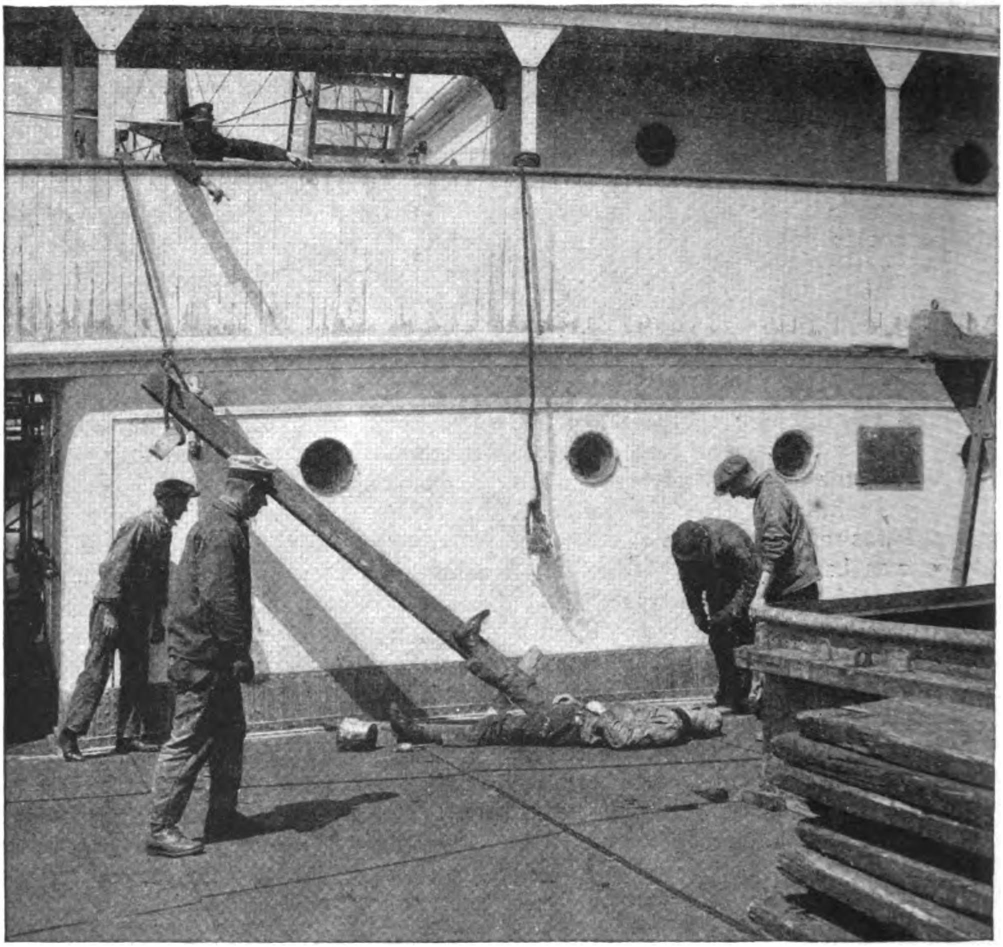
Another instance: the *Chester Valley*, one of the United States Shipping Board ships, was at sea when one of the petty officers began to complain of pains. Small sympathy is to be found among the hardened men of the sea until it becomes serious—and then before they realize it, it is too late. It is a stern school. The man's pains grew worse; the captain was sent for and in bewilderment stood over the moaning man. The captain called New York by wireless. Almost immediately advice was back. The man was saved and another feather was added to radio's cap.

On still another occasion, a sailor on a slow-moving cargo ship came down with pneumonia. To cure such a disease was quite beyond the ambitions of even the most adventurous members of the crew. It would be days before the freighter would make land—and the man must have immediate attention. At last a passenger ship was called and its doctor was asked to prescribe. This he did. The two ships were going in the same direction; the passenger ship arrived first and when the freighter came in the doctor, whose interest had been aroused, was there to receive his patient. The sailor was transferred safely to a hospital and in time recovered. Without radio a shorter—and sadder—story would have been written.

Thus do we see the workings of another of the wonders of radio—the giving of medical advice to ships at sea. Sailors now can have the best of medical advice, even though the doctor may be thousands of miles away. Many and many is the ship that has no doctor: freighters, cargo ships, tramp steamers, tankers, fruit boats, fishing vessels, schooners. In fact, only 25 percent of the ships that sail the seas carry doctors. There is a law which requires all ships with fifty or more in the crew to carry a radio outfit, but they may have a hundred in the crew and not have a doctor aboard—so long as they don't carry passengers. But a ship with even one paying passenger must have a doctor. It is one of the queer quirks of the law. To judge by the statutes a seaman is a hale and hearty individual who has felt well ever since he cut his teeth, while a passenger with nothing to do but sit around and enjoy himself is trembling on the brink of a breakdown. As a result, a freighter with a huge crew will start to sea with nothing more complicated in the way of medical nostrums than Nujol and be expected to put into port with every man jack aboard dancing a hornpipe. But if one lone passenger gets aboard, a ship's doctor has to come trailing after him.

The English marine law is better than ours. By it the master of a vessel is required to know the principles of first aid. But we have no such law. The captain of an American freighter can put to sea without knowing a hypodermic needle from a belaying pin. The English captain, in time of emergency, can administer rough help, but our captain can only look sympathetic and offer to write to relatives. As a result, thousands of American seamen suffer. And the stories they can tell! Boxes fall on them, legs are crushed, fingers disappear in the machinery—and the captain is called on to perform the office of doctor. Sailors hold the screaming man while the captain amputates. There is no opiate; the victim is tied to the bunk and the ship goes on. Engine-room waste is used to bind wounds and oakum is poured on open sores. When there is a burn, lubricating oil is emptied on it and the crisis is considered past.

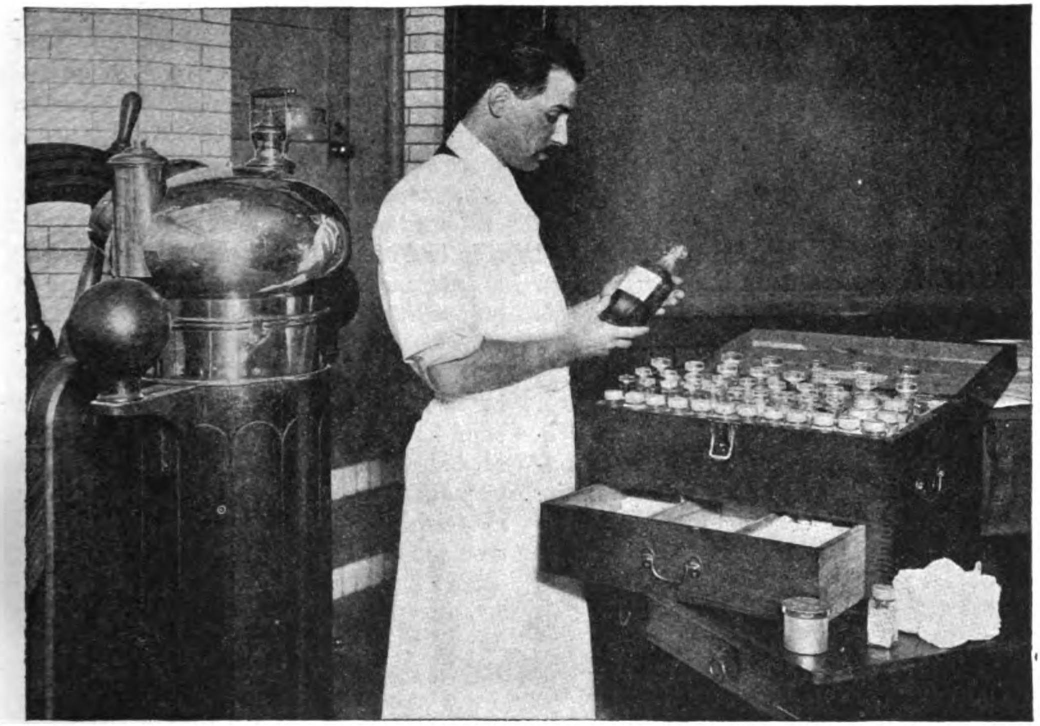
So it has been for many centuries.



From a photograph made for POPULAR RADIO

ACCIDENTS ON DOCTORLESS SHIPS HAVE BROUGHT HORRORS THAT RADIO IS AT LAST RELIEVING

For time immemorial, the only treatment received by injured seamen has been rendered by the ships' captains. Now the emergency ambulance call "KDKF" is bringing expert help even to the remote lanes of the Atlantic and Pacific.



From a photograph made for POPULAR RADIO

THE SHIP MEDICINE CHEST THAT HAS BEEN STANDARDIZED BY "DOCTOR KDKF"

Every vessel may some day be equipped with such a first-aid cabinet that will enable the ship's captain to administer the exact drugs prescribed by doctors via radio.

Then, one day, a man on the top floor of a sky-scraper at 25 South Street, New York, had an idea.

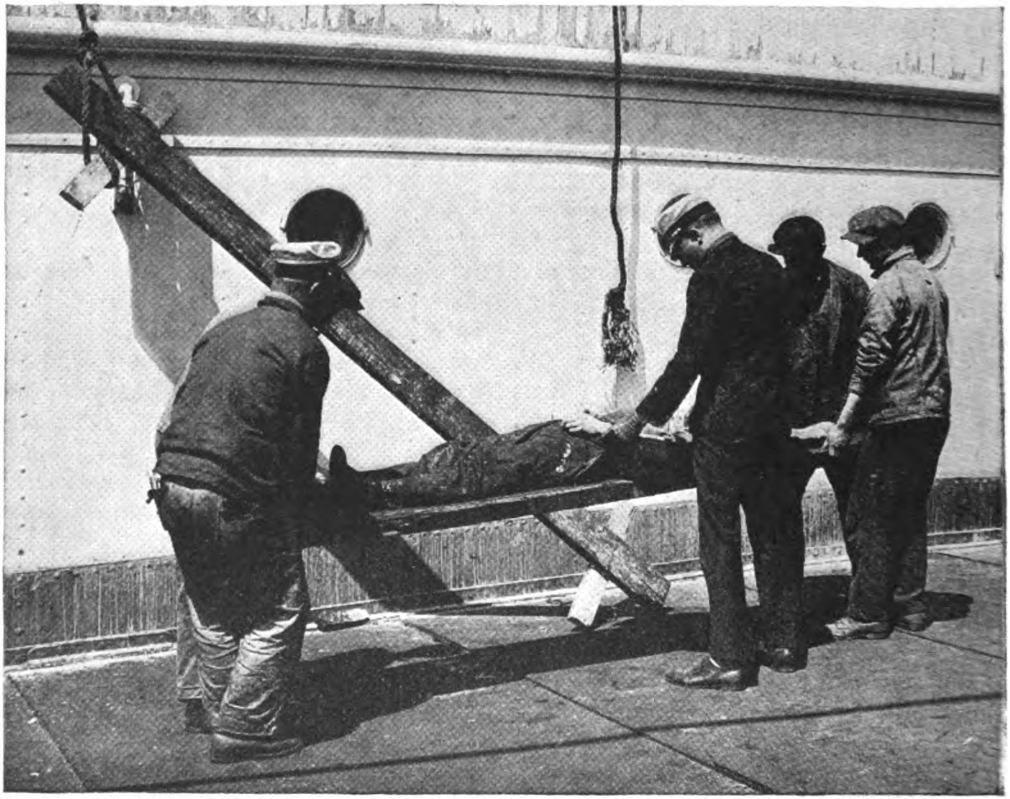
That man is Captain Robert W. Huntington, who has sailed the seas when sailing was sailing and scurvy was a dreaded disease. Once he went out to meet the whale and stood with his finger on the trigger of the harpoon-gun; now he is in the quieter waters of New York Harbor, but his heart is still with the sailors setting their course by the evening star.

"Why can't we give them medical advice by radio?" he asked.

It was a new idea; it had never been tried. He was connected with the Seamen's Church Institute as chief of the navigation school. Immediately his idea was put up to the authorities. There was a medical staff with the Institute giving advice to sailors ashore; now its services could be enlarged. Washington was communicated with and soon the only doctor thousands of sailors knew was KDKF. When pains set upon them, or when their hands went into the machinery, instead of trusting themselves to the efforts of a bewildered skipper they called the mysterious Dr. KDKF and after a short interval advice came back. That was all they knew. The machine would sputter, sparks would fly and from some place out of the air advice would come.

But this was what was really happening. As soon as the distress message was received an Institute doctor was communicated with. The message was read to him. He in turn telephoned advice back, but the Captain wasn't going to run any risk; passing through so many hands the advice might be garbled. So to the telephone he hitched a dictating machine, and the doctor's instructions went on wax. These in turn were read back to the doctor and later the record was put away for safe keeping. With the rubber tips in his ears the captain read out to the wireless operator the exact words of the doctor and into the air they were sent flying. The radio operator aboard some lonely ship copied them down and the message was given to the captain. Then, confident of his medical bearing, the ship captain went to the sailor and gave orders with as much assurance as if he had a medical degree. The message, to reach its destination, had gone through four machines—the telephone at the hospital, the wax record, the sending outfit and the receiving outfit on the ship.

So far so good; a great boon had come to the sailorman—or so it seemed. But not as much oil had been poured on the troubled waters as the quieted waves might seem to indicate. Underneath, there was still something wrong. For many times when calls came in for help, and medical advice was sent back, the ship had none of the remedies suggested; in fact, outside of castor oil, calomel and quinine the ship's medical chest was as bare as Mother Hubbard's cupboard. The doctor might prescribe relief, but he had no means of knowing that the ship had this on board. He was prescribing in the dark. Then it was that Captain Huntington hit upon another idea—the idea of the standardized medicine chest.



From a photograph made for Popular Radio

FIRST AID IS NOW RENDERED *VIA* WIRELESS

Not only can the nature of accidents be reported to distant surgeons, but even the patient's heart-beats may be transmitted to him for determining the physical condition. Many a broken bone has been set by instructions received by radio.

Each ship going to sea was to be equipped with a medicine chest in which were to be all the standard drugs and remedies. These were to be plainly marked; the doctor was to know exactly what was aboard the ship and then he could dovetail complaint and treatment. The matter was taken up with the Department of Commerce and was favorably received. It is now awaiting action. If passed it will bring relief to thousands of seamen who in the past, in the words of the fo'c's'le, have had to grin and bear it. The supplies are to be bought by the United States Public Health Service, that cheap and inferior drugs are not foisted upon the seamen, and inspected from time to time to see that their strength has not deteriorated.

The work of the Seamen's Church Institute continued, and legs were saved and stomachs were calmed, but the job became too big. It meant that an operator must be on duty day and night. Money was low; a few donations came in, but it was more than the Institute could manage on its slender resources. At last arrangements were consummated with the Radio Corporation of America and this in turn with the United States Public Health Service. The doctors of the latter are at its call. It now has stations at Chatham, Mass,; Siasconset, Mass.; on the Bush Terminal Building, Brooklyn; one in Cape May, New Jersey, and another in San Francisco. The call letters, in order, are: WCC, WSC, WNY, WCY, with KPH for San Francisco.

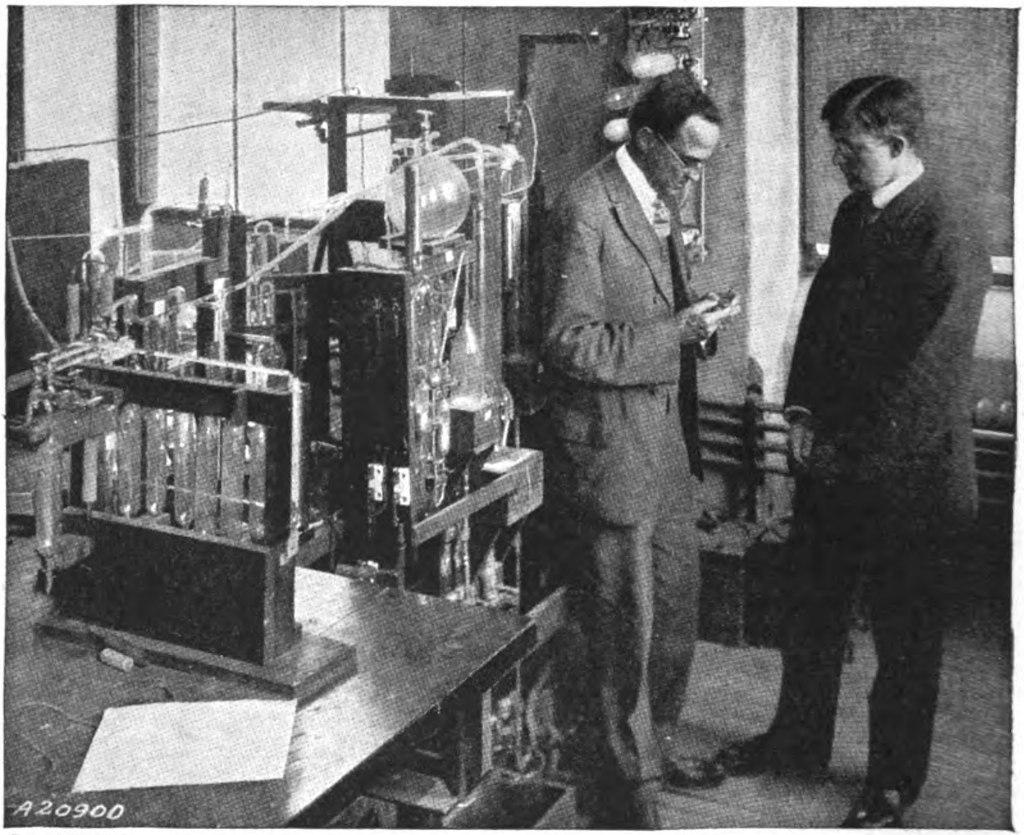
"SPARKS"

The law requires every ship that carries a crew of fifty or more to carry along a radio outfit also. The radio operator is known aboard as "Sparks."

Thousands and thousands of sailors—who once suffered and died needlessly—now, in whatever part of the world they are, can have medical aid within a few minutes. In fact, it is now possible for a sailor in the Sargasso Sea to get attention more quickly than if the doctor lived a few blocks up the street. With radio there is always a doctor at home. Radio has hung a shingle on every ship.

The HOOK-UP NUMBER
Will Be Published Next Month—November

¶ *In response to the demand for diagrams and descriptions of radio circuits—practical, tested hook-ups that the radio novice and the radio amateur can adapt to his own needs*—POPULAR RADIO *will feature this subject in the next issue, November, out October 15th. Ask your newsdealer to reserve your copy for you. Ask him TODAY!*



General Electric

A SCIENTIST WHO CONTRIBUTES TO THE WORLD AN ALMOST-PERFECT NOTHING

Dr. Irving Langmuir (at right), inventor of the Langmuir pump that has removed about 99.999,999,990 percent of air from a tube, and who has thus made possible the high vacuum tubes used in radio. He is conferring with Dr. W. R. Whitney.

The Bottle Filled With .000,000

The Key to the Radio Art Is the Vacuum Tube; the Secret of the Vacuum Tube Is the Vacuum Created Inside of It. This Article Reveals How this Vacuum Is Made

By E. E. FREE, Ph.D.

MODERN radio depends upon our ability to fill a bottle with nothing. The bottle is the vacuum tube. The nothing is the vacuum.

To the layman this seems perfectly simple. You merely take a glass bulb and pump the air out of it. Inside you have a vacuum.

The physicist knows that this is easier to say than to do. For hundreds of years science has been trying to learn how to pump all of the air out of anything. So far science has failed. No one has ever gotten out every last molecule and atom of air and of every other gas. No one has produced an absolutely perfect vacuum. Probably no one ever will. Nature not only abhors a vacuum, but she takes mighty good care that nobody ever gets one.

But science has come very close to a perfect vacuum. After many years of research, after the laborious study and improvement and final rejection of scores of different methods of producing a vacuum, science has come at last close enough to perfection for the practical problem of producing a workable electron tube for radio use. This was done, as it happens, not for radio purposes at all, but in connection with some fundamental scientific researches on the theory of the ordinary incandescent lamp and on the X-ray tube; one more example of the way in which scientific researches undertaken for one object or for no object at all except the pursuit of knowledge, turn out so often to be useful in directions originally quite unforeseen.

This is the story of the present state of this long search for the perfect vacuum, of why high vacua are necessary in radio tubes, of how they are produced, of why a perfect vacuum is so exceedingly hard to get, of how air molecules penetrate into solid glass and then boil out of it as they might out of water, of how this and other experimental difficulties have been fought and overcome. Were it not for the success of the scientists in these researches (partial success though it is) the radiophone as we know it could not exist. You can receive with a crystal but you cannot send with a crystal. Modern radio depends absolutely on the vacuum tube, on some or all of its many uses. And the vacuum tube is possible only by virtue of what science has discovered about vacua and how to get them.

The most perfect vacuum attained so far by any scientist is one in which the remaining gas—the tiny fraction by which the vacuum fails of being perfect—has a pressure of about .000,000,075 millimeters of mercury. The ordinary air pressure is about 760 millimeter of mercury. In this almost perfect vacuum, therefore, about 99.999,999,990 percent of the air has been removed. Less than one ten-billionth of the air originally present has been left.

Scientists and engineers have three common ways of denoting gas pressures. One is the equivalent mercury column, as in the ordinary barometer, and as used above. Another is in pounds per square inch. A third is in "atmospheres," one atmosphere being the normal pressure of the air at sea-level. An atmosphere equals approximately 760 millimeter of mercury, or 14.5 pounds per square inch.

The record vacuum noted, the vacuum of .000,000,075 mm. of mercury, equals approximately .000,000,001,4 pound per square inch, or a little less than one ten-billionth of one atmosphere.

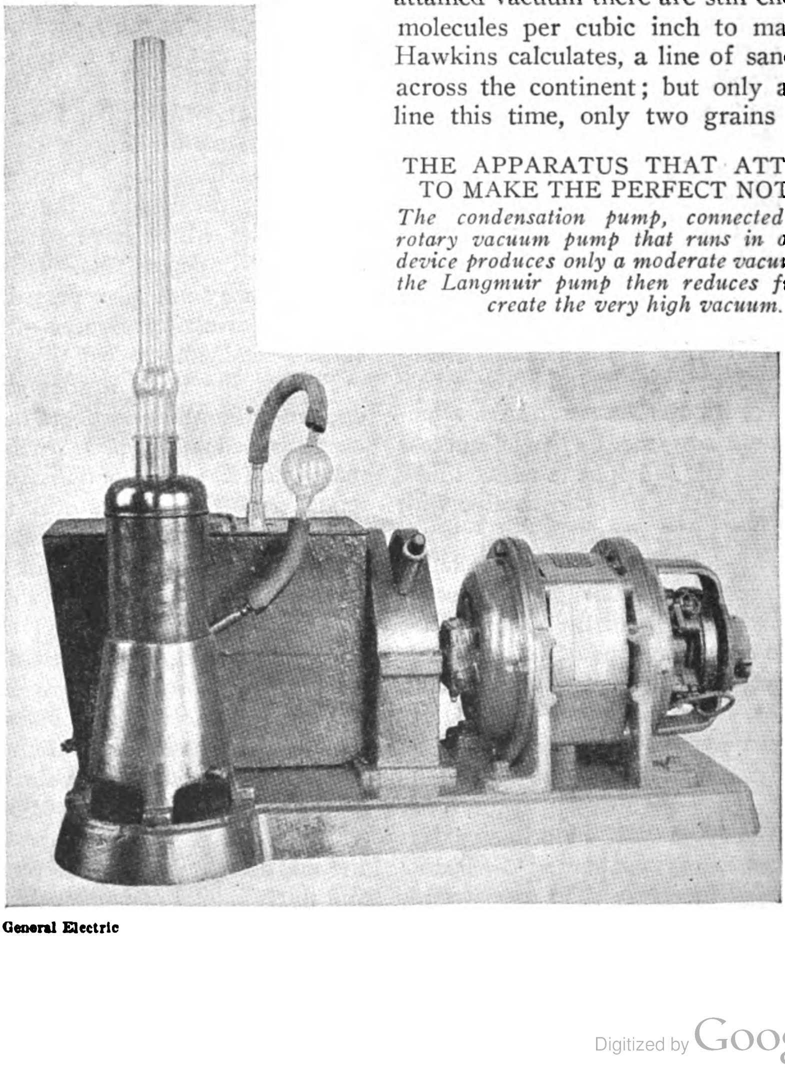
Though this is the measured record it is possible that vacua slightly more perfect than this have been attained in some of the experiments. The measurement of these very low air-pressures is extremely difficult. Ordinary barometers and gauges are useless, and the very delicate instruments which have to be used are not perfectly dependable. It is suspected that they may not have recorded perfectly the lowest pressures—the highest vacua—attained.

But, at the least, a vacuum of about one ten-billionth atmosphere has certainly been reached; it has been reached, indeed, many times. Yet even this extreme attenuation of the air is still far from a perfect vacuum. The evacuated bulb is not really empty. An ordinary vacuum tube for radio use has a volume of at least two ounces, about 50 cubic centimeters. At the highest attained vacuum of one ten-billionth atmosphere a tube like this will still have inside it about one hundred and thirty billion molecules of air—more than eighty times as many molecules as there are people living in the world.

And this tube, with its one hundred and thirty billion gas molecules still inside it, is the emptiest space that anybody has ever produced, the last word of science in perfect vacua. It is the highest vacuum known to man, a vacuum obtained only after years of research and after overcoming the most extraordinary experimental difficulties. And yet, with the best that science can do, there are still one hundred and thirty billion gas molecules inside a tiny two ounce tube. Each man, woman and child in the world could take away, out of this "empty" bulb, a flock of eighty little air molecules for personal pets. Nothing could give you a better idea of the almost inconceivable minuteness of those molecular sizes.

Even in the "empty" bulb the mathematical totals are astonishing. Only those who can remain undizzied on top of the tallest mathematical peaks will dare to calculate how many pet molecules could have been provided from the original air-filled bulb before 9,999,999,999 ten-millionths of these molecules were pumped out and thrown away.

A novel way of getting at the visualization of these staggering molecular totals is due to Mr. L. A. Hawkins, one of the engineers of the General Electric Company. Suppose, he says, each air molecule enlarged to the size of a fine grain of sea-sand, one hundredth of an inch in diameter, the molecules in a cubic inch of ordinary air would make a beach extending from New York to San Francisco, one thousand feet wide and over ten feet deep. This is for a cubic inch, about one-half of the air in an unexhausted radio tube. After exhaustion to the highest attained vacuum there are still enough air molecules per cubic inch to make, Mr. Hawkins calculates, a line of sand grains across the continent; but only a double line this time, only two grains side by



General Electric

THE APPARATUS THAT ATTEMPTS TO MAKE THE PERFECT NOTHING

The condensation pump, connected with a rotary vacuum pump that runs in oil. This device produces only a moderate vacuum which the Langmuir pump then reduces further to create the very high vacuum.

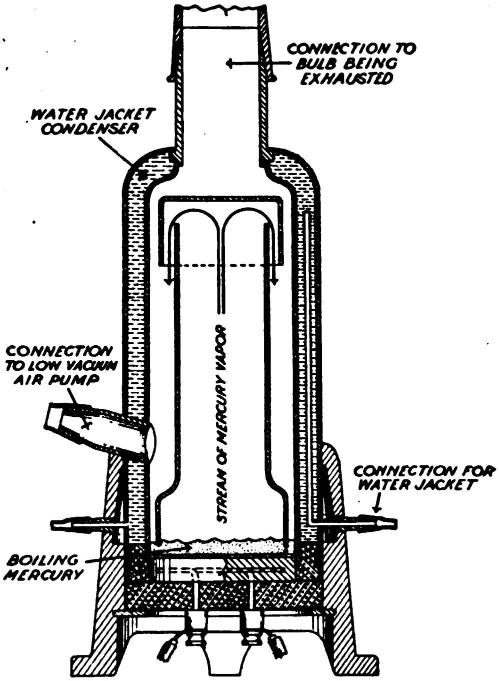
side, instead of the thousand foot beach.

Inside the ordinary commercial radio tube there are many more air molecules than this. The most perfect attainable vacua are not necessary for ordinary work and, because they are very expensive to produce, they are not used. All that is necessary is a good vacuum, a vacuum perfect according even to the scientific standards of twenty years ago, but considerably less perfect than the vacua now attained for important scientific researches. The ordinary commercial tube is exhausted to about .00001 millimeter of mercury, corresponding to about one hundred-millionth of an atmosphere. This means that there are left in the tube about one hundred times as many air molecules as are in the bulb which we talked about above, the bulb exhausted as highly as possible. In the ordinary tube the molecules total over thirteen trillions. But this is still too few to interfere with the operation of the tube.

First, however, let us see why a vacuum in the tube is necessary at all.

As every radio fan knows, the operation of the vacuum tube depends upon electrons, which are little particles of electricity. These electrons fly off from the hot filament of the tube, cross between the wires of the grid and hit the plate. The passage of the electrons causes an electric current to flow between the plate of the filament and the charge on the grid affects the strength of this current. The tube serves, therefore, to detect or to amplify changes in the potential of the electric charge on the grid. Everything depends on the electrons. If they do not fly off properly from the hot filament and pass across to the plate, the tube will not work.

Air molecules left in the tube, or any kind of gas molecules left in it, affect the behavior of the electrons in two ways. *First,* they interfere with the flying off of the electrons from the hot filament. *Second,* they cause what is called "ionization."


CONNECTION TO BULB BEING EXHAUSTED
WATER JACKET CONDENSER
CONNECTION TO LOW VACUUM AIR PUMP
STREAM OF MERCURY VAPOR
CONNECTION FOR WATER JACKET
BOILING MERCURY

THE LANGMUIR PUMP

The device used for creating a vacuum in the tubes used in radio. This diagram illustrates the construction of the metal form of pump.

Proper electron emission from the filament, their continual flying off in sufficient quantity, requires a clean filament, a surface of metal freely exposed for the electrons to get out of. If there is much gas in the tube, some of the gas molecules attach themselves to the surface of the filament and keep the electrons from getting out, much as crawling moths or flies will stick to the surface of an outdoor lamp at night and keep the light from getting out. A little gas in the tube does small harm, just as a very few flies would interfere scarcely at all with the brilliancy of a lamp. And ten or fifteen trillions of molecules is really very few, considering their very small size. Millions of them could crowd together on the point of a needle. In comparison with a molecule, the surface of the hot filament is a broad and empty plain.

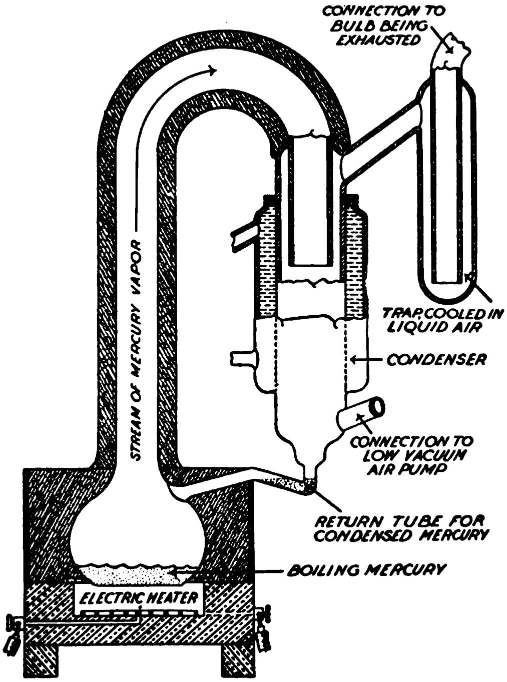
Ionization works differently to affect the electron current. When an electron flies off from the hot filament it is moving very rapidly; speeds up to 60,000 miles a second have been observed. In an assemblage of gas molecules such a fast moving electron behaves exactly like a high-power cannon ball in a crowd of people. Presently the electron hits a gas molecule and when it does it knocks the molecule apart. Frequently it knocks another electron out of the molecule, for electrons, remember, are contained in all molecules, in the gaseous ones as well as in the metalic molecules of the filament.

A gas molecule which has been assaulted in this way and has lost one or more of its electrons is called an "ion." From the viewpoint of this article an ion has one especially important property. It carries a predominating positive electric charge, whereas the charge of the electron is negative. These positively charged ions set up, therefore, an electric traffic reverse to the traffic of the electron current. The electrons are negative. They move from the filament to the plate. The gaseous ions are positive. They tend to move from the plate toward the filament. This causes all kinds of confusion. The traffic gets into a snarl and the tube ceases to work properly—to work properly, that is, as a radio detector or amplifier. There are certain other kinds of tubes, such as a rectifier tube, used in changing alternating current into direct current, in which the presence of ions inside the tubes is desirable. Such tubes are filled with nitrogen or with the rare gases argon or neon. But in ordinary radio tubes ions are troublesome; consequently the less gas in such tubes the better they work.

It is not necessary, however, to have absolutely no gas. The few trillion molecules inside the ordinary tube do no harm. They are so scarce, relatively, that the electrons, which themselves are far smaller than a molecule, seldom hit them. The crowd is too thin. The cannon balls go through without doing any real damage. In the ordinary tube there is not enough ionization to do any harm. In the very best vacua there is practically no ionization at all.

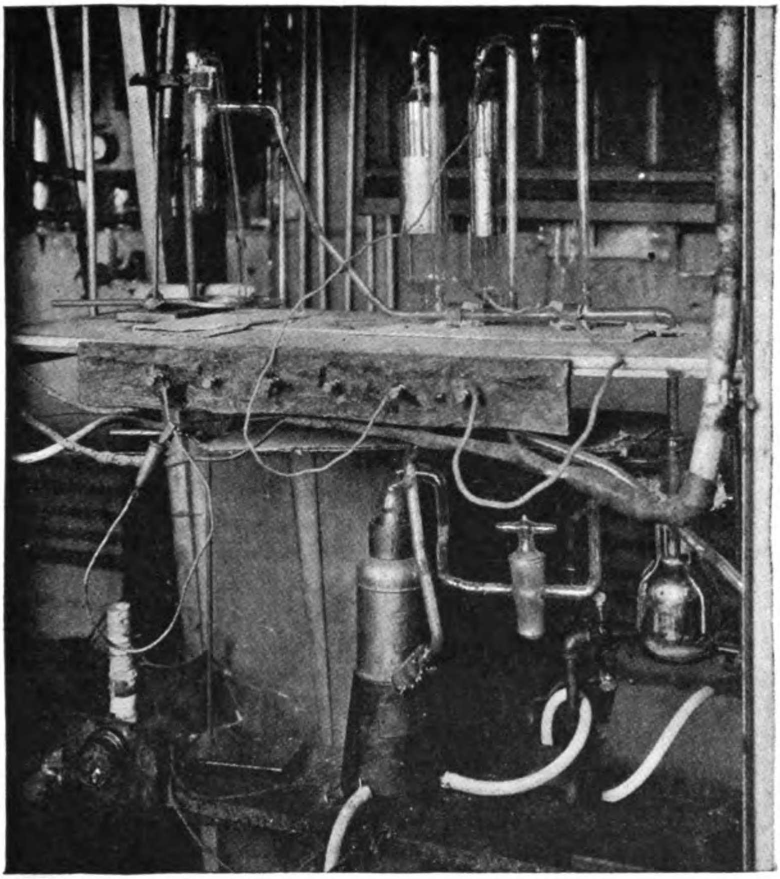
These very best vacua, including the record vacuum of one ten-billionth of an atmosphere, have been made possible by an apparatus developed by Dr. Irving Langmuir of the Research Laboratory of the General Electric Company. It is called the Langmuir condensation pump. The principle of this pump is very similar to that of the ordinary steam injector used to draw water into steam boilers. In these injectors a blast of steam is blown through a nozzle in a pipe filled with water and directed into the boiler. As the steam blows out of the nozzle it picks up some water and carries it along into the boiler.

An analogy which is more familiar, even if not quite so similar in scientific principle, is the way in which water running out of a bathtub will suck the air down with it through the tub outlet. The


CONNECTION TO BULB BEING EXHAUSTED
STREAM OF MERCURY VAPOR
TRAP COOLED IN LIQUID AIR
CONDENSER
CONNECTION TO LOW VACUUM AIR PUMP
RETURN TUBE FOR CONDENSED MERCURY
BOILING MERCURY
ELECTRIC HEATER

HOW THE PUMP WORKS

A sectional view of the Langmuir apparatus for producing the vacuum in the triodes. This form is constructed of glass for laboratory use.



General Electric

MAKING THE HIGHEST KNOWN VACUUM

The Langmuir pump in actual use, creating an almost-perfect vacuum in the electron tubes seen on the work bench. At the right is a thermos flask containing liquid air, to cool the tube connecting the pump and the bulb that is being exhausted.

stream of running water entraps some air and takes it along down the pipe.

In the Langmuir pump, instead of a stream of steam or of water we have a blast of gaseous mercury, of the vapor from boiling quicksilver. This blast of mercury vapor blows out of a nozzle into a glass tube connected to the bulb from which we wish to draw out the air. As the blast of mercury vapor blows along through the tube it takes some air with it, entangles the air molecules in the great crowd of mercury molecules and drags them along. The farther part of the glass tube is kept cold. The hot mercury vapor condenses to liquid mercury and is returned, as a liquid, to the little heater which serves as a boiler. Here the liquid mercury boils away again and supplies new mercury vapor to keep up the blast.

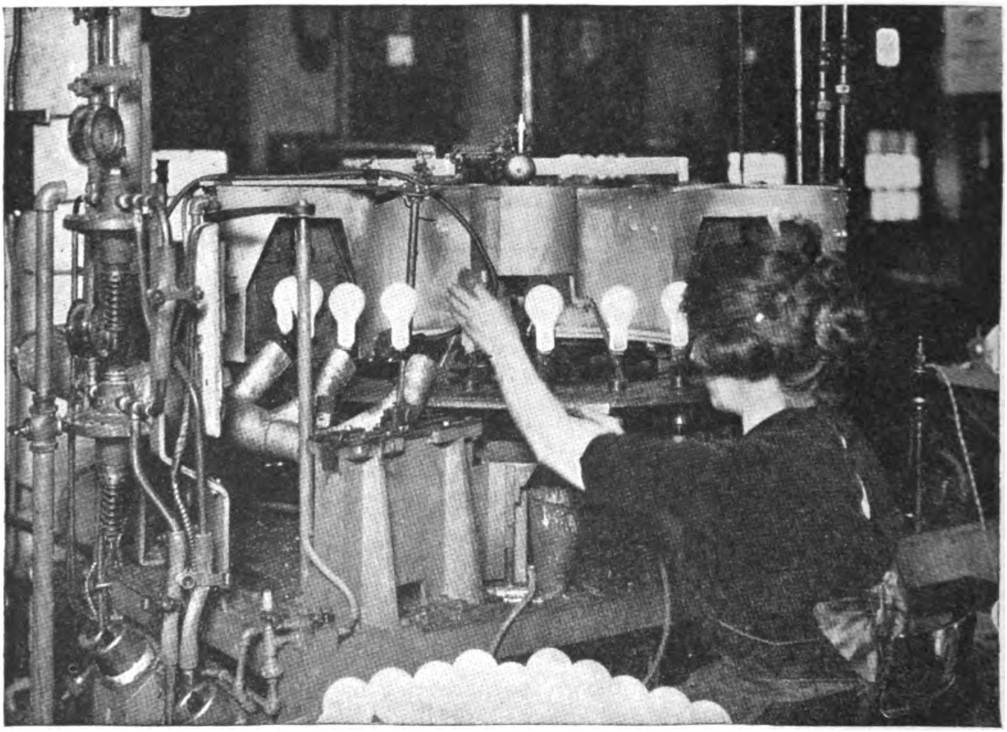
But the molecules of air which were with the mercury do not condense. They have been carried out of the tube and they stay out. They cannot get back in, against the blast of mercury molecules, any more than one man can make headway against a running crowd.

There are some practical precautions necessary in using the Langmuir pump. For instance, a part of the tube which connects the pump with the bulb to be evacuated is cooled in liquid air, cooled to a temperature of about 290 degrees Fahrenheit below zero, or even lower.

This freezes and keeps out any mercury vapor which might otherwise get back into the evacuated bulb and produce in it an atmosphere of mercury gas; for mercury does make a gas, though a very thin one, at ordinary temperatures.

Another great experimental difficulty which has to be overcome in high-vacuum work is due to the gas which is given off from the glass walls of the bulb, from the metal filament and from anything else which may be inside the bulb. The experiments of Dr. Langmuir and of Dr. Saul Dushman have proved that everything contains a great deal of gas. For instance, air will penetrate into solid glass, into solid metal, into nearly everything else. Physicists call this gas *adsorbed gas*. When a glass bulb is evacuated this adsorbed gas comes off slowly—boils slowly out of the glass or metal or whatever is inside the bulb. It may take days or weeks for all of this gas to come out. Indeed, it is probable that it never *all* comes out, that a little of it is always left—inside the solid matter of the glass or metal.

Of course this adsorbed gas, as it comes gradually out of the glass walls of the bulb, spoils the vacuum in the bulb. To get around this, the bulb, the filament and everything else is heated in a furnace as hot as it is possible to heat it without softening the glass. While hot, the bulb is exhausted by the pump. This is repeated many times until as much of the adsorbed gas as possible has been cooked out. Even then they never get quite all of it. A little will come out later for months, probably for years. This is one reason why an absolutely perfect vacuum has not yet been attained.



General Electric

CREATING VACUUMS IN THE LITTLE BROTHERS OF THE RADIO TUBES

On this rapidly moving machine ordinary lamp globes are exhausted on the turntable that carries them through the oven; as they come out (at left) they are cooled by three blasts of air.

These are some of the ways in which Nature fights against the perfect vacuum. So far Nature's efforts to prevent man from attaining the perfect vacuum have been successful. But there is one way in which Nature helps. This is the phenomenon called the "clean-up."

It was observed years ago that when a tungsten-filament electric lamp, like an ordinary mazda lamp, was burned for a while the degree of vacuum inside the lamp globe increased. Some of the air which had been left in the globe when it was made disappeared on use. The gases were "cleaned up"; hence the name of the phenomenon.

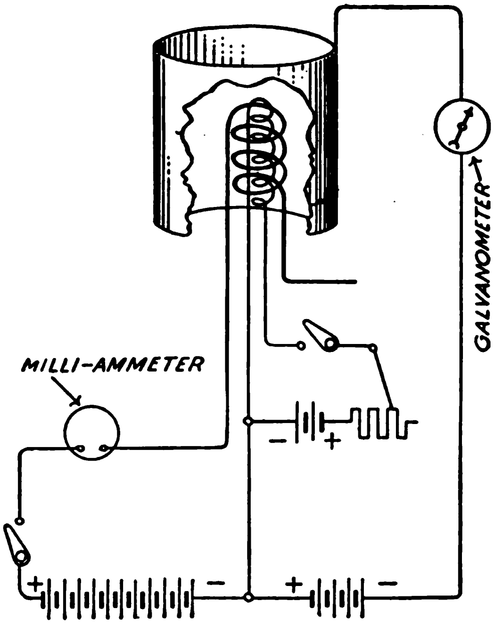
The scientific reasons for this clean-up have now been investigated. There are believed to be several ways in which it happens, in which the gas molecules are got rid of. Some of the molecules combine chemically with the metal of the filament, others with the materials of the glass wall or of something else inside. Many of them, Dr. Dushman thinks, are ionized by collision with electrons and are then shot off so violently, either by the mere collision or by electrostatic repulsion, that they penetrate deeply into the glass wall of the bulb and stay there, just as a bullet shot against a plank will go in and stick. Some of these ionized molecules may be shot at the glass wall of the globe so fast and so powerfully that they go clear through into the outside air and get away altogether.

The clean-up helps us toward a perfect vacuum; but it has not, as yet, enabled us actually to attain it.

Will science ever attain a perfect vacuum? What can we expect from continued research? Science is accustomed to hope and try for absolutes; the perfect conductor, the absolute zero of temperature, the ultimate particle of matter. Can we look forward to the attainment of an absolutely empty space?

Who knows? Recently there came prospect of help from an unsuspected quarter—from the Army's investigations on gas masks. An essential part of the gas mask was the powdered charcoal contained in the little tin box called the canister. The duty of this charcoal was to absorb certain of the poisonous gases. It was found, in studying this, that charcoal absorbed all gases, and the scientists of the Chemical Warfare Service were able to prepare, before the armistice, certain special kinds of charcoal which were hundreds of times better as gas absorbers than ordinary charcoal is. These special charcoals have been tried by Dr. Dushman as means of removing the last trace of gas from high vacua. They promise to work very well.

Perhaps something of this sort, used in connection with the Langmuir pump, will give us before long a still nearer approach to Nature's traditional abhorrence, a space containing nothing at all.



HOW GAS PRESSURES ARE MEASURED

Connections for the ionization gauge used in measuring small gas pressures. Electrons are produced by the inner hot-wire filament and pass across to the outer filament; these electrons ionize the gas in the tube and the positive ions are collected by the surrounding molybdenum cylinder. The number of positive ions is measured by the galvanometer and is proportional to the number of gas molecules in the tube.

From a heretofore unpublished photograph

←Sir Arthur Conan Doyle, the famous spiritualist, and Harry Houdini (professionally known merely as "Houdini") are close friends—as this snapshot indicates. "I respect Sir Arthur for the sincerity of his beliefs in spiritualism," states Houdini. "But I do not share them."

Ghosts that Talk —by Radio

An Exposé of Some of the "Spiritualistic Phenomena" Perpetrated by Fraudulent Mediums for Getting Money from Their Credulous Followers

By
HOUDINI

The author of this article is the president of the Society of American Magicians. All the members of that exclusive organization are pledged to keep inviolate the tricks of their profession—except when those tricks are used for dishonest purposes. Houdini (who in order to study "spiritualistic phenomena" once entered the ranks of the professional mediums himself) properly considers those mediums dishonest who claim that voices transmitted by confederates by low frequency induction or "inductive radio" are the voices from the dead. He is, accordingly, as a public duty, disclosing in this article how these tricks are performed.

MAGICIANS have used the radio telephone in their performances for several years—long before radio was generally known to the public. I am not at all surprised that the radio is being used by fraudulent mediums to convince their patrons that they are in direct communication with the dead.

I regret profoundly to admit that in over thirty years of investigation, during which time I have attended hundreds of seances with a mind ready and eager to discover some sign from those who have gone to the Great Beyond, I have never witnessed anything that I could accept as evidence that there was life beyond the grave. All the "evidence" that I have seen is merely phenomena that are well known to the average magician. What are "wonders" to the average human being are merely everyday tests that are familiar in the profession. In performing some of these experiments I have myself seen men and women faint away, overcome with what they thought were supernatural occurrences. As a matter of fact I was merely performing more or less common tricks.

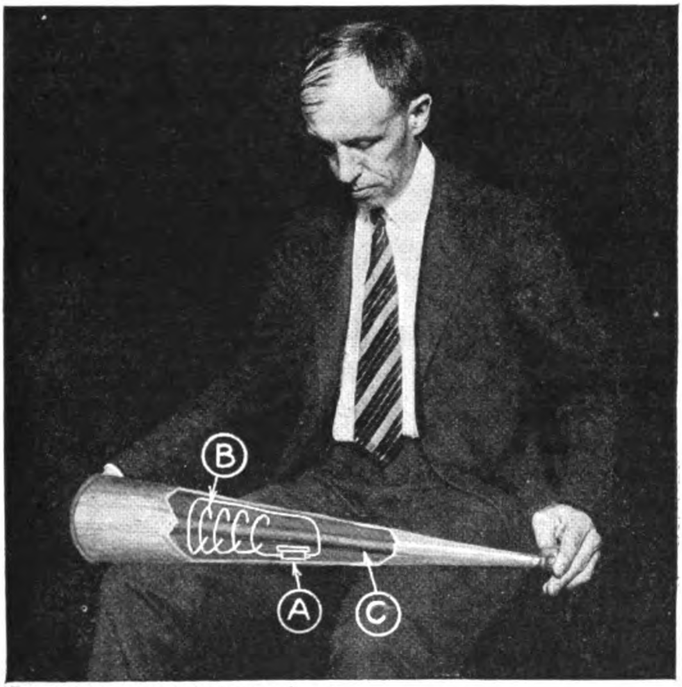
The passing away of my mother first started me on a serious investigation of the doctrines and claims of the spiritualists. Only those who have lost their loved ones can know the fervor with which such investigations can be pursued. There is no sacrifice I would not make to be able to get in communication with my mother. After years of research I still hope that there is a way of communicating with her from this life. But I have no faith in the existing forms of communication as known to mediums or practised by them at the present time.

There is not the slightest doubt in my mind that such men as Sir Oliver Lodge and Sir Conan Doyle are sincere in their beliefs. They regard spiritualism as a religion; to them it is something sacred. They think that the evidence they have obtained is sufficient evidence to justify their faith in their "communications" with those who have passed beyond. I respect them for their sincerity. But I do not share their beliefs.

I have made definite compacts with seven intimate friends and relatives to the effect that the one who died first would communicate with the others. All of my seven friends are dead. Up to the present time I have not received the slightest sign from any of them. In order to get into communication with them I have gone to seances conducted by famous mediums. Yet I never received any sign that was not obviously a trick on the part of the medium—a trick with which I was thoroughly familiar.

The human senses are easily deceived. People believe what they want to believe. The human being is always seeking something in which he can put his faith. A combination of deception and faith is capable of leading human beings to almost any extreme of self-delusion. It is the business of the mediums to capitalize this faith.

I exposed a medium in Bochum, Germany, twenty years ago by throwing ordinary carpet tacks under his bare feet when he came out to the audience in a dim light and posed as a spirit from another world. Today I would need a radio receiving set to uncover his latest deception. Before attending this seance I had been repairing one of my cabinets and had a number of tacks in my pocket. I casually threw them on the floor before the curtain in front of the opening whence the ghost of Cæsar was to appear and lecture. The medium who impersonated Cæsar stepped upon the tacks and burst forth into a profusion of German oaths.



From a photograph made for POPULAR RADIO

THE FAMILIAR TRUMPET OF THE SPIRITUALIST MEDIUM

Only in this case the instrument is fitted with (A) a telephone receiver that converts the received current into sound and (B) a receiving coil that collects energy from the transmitting coil, which may be hidden some yards away—all concealed in false sides. (C) is the orifice through which the voice issues. The medium's confederate may be located several yards away.

Radio has given the "spirit business" an enormous boost in the last few years. While the rest of us have just been getting acquainted with it, many of the so-called psychics have been reaping a harvest.

I love an honest-to-goodness trick that mystifies and entertains me. It is my business to know them all and to try to perform them better than other magicians. As President of the Society of American Magicians, numbering over 1,000 members, it is my duty to hold such tricks; indeed, we have all taken an oath not to reveal them. But concerning the deceptions of fraud mediums—that is another matter. I regard it as the duty of every thinking man, whether or not he believes in spirits, whether or not he believes in God, to expose imposters who profane the concepts of future life merely to extort money from believing souls who in their ignorance misplace their confidence.

A total of $300,000 was extorted by one clever medium from Luther B. Marsh (the law partner of Daniel Webster) in 1888 by the use of a primitive radiophone. Her name was Ann O'Delia Dis Debar, and she made a spectacular career for herself until she was exposed in court by Alexander Herrmann and Carl Hertz.

There have been countless other swindles through the invention which has been practically unknown up to the present time. The device was little more than ordinary telephone by induction in most cases, but in the more intricate deceptions the principles of modern wireless telephony were employed.

I have the largest library of magic in the world. It was while trying to buy books that I read of the auction of a well-known medium in New York, and the day before the sale I bought all of her books and bound volumes of the publication, "Medium and Daybreak." I was shown a kettle, and as I knew that the kettle was used by mystifiers, bought this also.

The device was a "talking kettle." When the proper "spiritual connections" had been established by the medium, through her facial and bodily contortions in the approved "psychic manner," the kettle became most intelligent. Anyone in the room could ask the kettle a question and receive an intelligent answer at once by placing the spout of the kettle to his ear. The answer would come in a whisper, a most ghostly whisper, such as is familiar to those who have attended spiritualistic seances.

That same kettle is now installed in my home and it talks to my friends in the same kind of whisper with absolutely no change except the replacement of the battery. Sane men of prominence in public life, men who should by all means suspect me of trickery, have actually been deluded by this simple device.

There is no doubt in my mind but that I could cause a great many people to believe that spirits speak through the medium of the kettle; in this way I could merchandise spirit messages for substantial sums of money.

The kettle can be handled and carried about the room while it is whispering, turned upside-down and otherwise explored.*

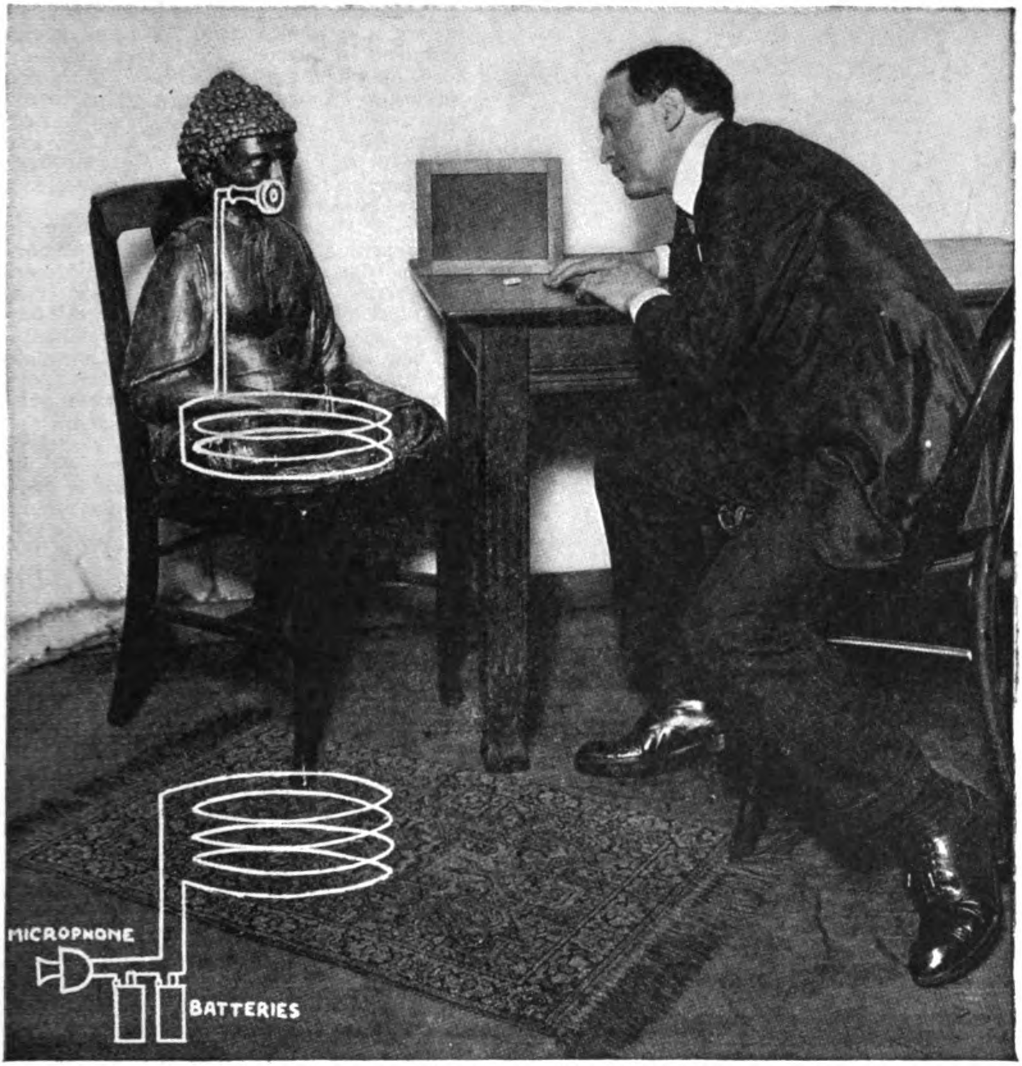
---

*While the author does not feel at liberty to describe the operation of this kettle, the explanation of it is obvious. The secret lies in the radio receiving apparatus that is concealed in its hollow walls. The kettle is made of *papier-mâché*, so that it will not absorb the radio waves which are intended for the aerial coiled inside. The medium who operates the kettle or similar radio device must have a confederate in an adjoining room, who hears everything through a sensitive microphone concealed in the room where the seance is held.

One of the best devices for concealing such a microphone is an oil painting, a painting made on gauze rather than canvas. By placing a deep shadow box over the picture the thin gauze is made to look like canvas. The shadow box acts as a resonator for the sounds in the room and the thin gauze enables the sounds to pass to the microphone with but little obstruction.

The confederate in an adjoining room may thus hear every question that is asked in the room and make his replies by radio. The transmitting wireless instruments are placed in the room with the confederate, but the transmitting antenna is concealed in a rug directly beneath the kettle. This arrangement makes it necessary for the radio waves to travel only a few feet to reach the receiver in the kettle, so that not much power is required for transmitting.

With modern improvements in radio, the kettle may be carried to any part of the room, and with the sensitive microphones they are making today, the slightest whisper can be heard by the confederate who may be elsewhere in the building, or even at some distant point.—EDITOR.



From a photograph made for POPULAR RADIO

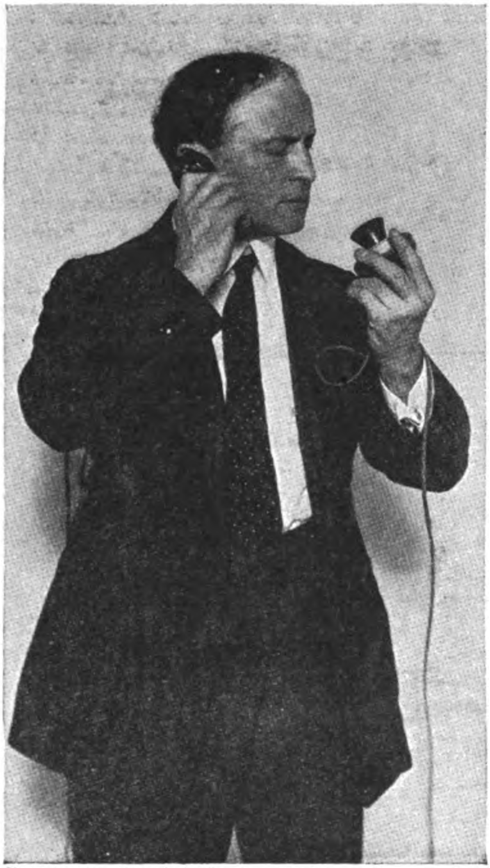
ANOTHER COMMON "PHENOMENON"—THE TALKING IMAGE

The voice of the medium is transmitted to the confederate in another room by the ordinary microphone. The confederate's reply is transmitted into another microphone that is connected with a transmitting coil concealed in a rug (or other object). This energy is collected by the receiving coil in the statue and is converted into sound waves by the telephone receiver concealed in the image's head.

Sometimes my friends ask questions in such a low tone of voice that I cannot hear them; they are, accordingly, completely converted to the belief in spirits when the kettle answers. This "spirit-talking" kettle has been used by mediums for years; it is the invention of David Abbott, who devised it for purposes of entertainment only.

To the best of my knowledge the first application of the principles of radio to spiritualistic manifestations was in 1852, when Jonathan Koons, a farmer of Dover Village, Ohio, installed a "spirit machine"—described as a "crude structure of zinc and copper for localizing and collecting the magnetic aura."

This radio telephone trick is per-



From a photogaph made for POPULAR RADIO

THE "SPIRIT" LISTENS AND SPEAKS

The ears and mouth of the "talking" objects are merely microphones in the hands of the medium's confederate—who may even be in another building.

formed in many ways. Statues of Buddha are among the popular bits of property employed by mediums; they are made to answer questions as glibly as hollow balls and trumpets.

In my collection of old clippings from magazines and newspapers, I find a description of the trick reported in the *Gazette de France* some years ago. The pages are yellow and the printing is old fashioned. The story concerns "The Invisible Girl" who mystified all Europe. To quote the article:

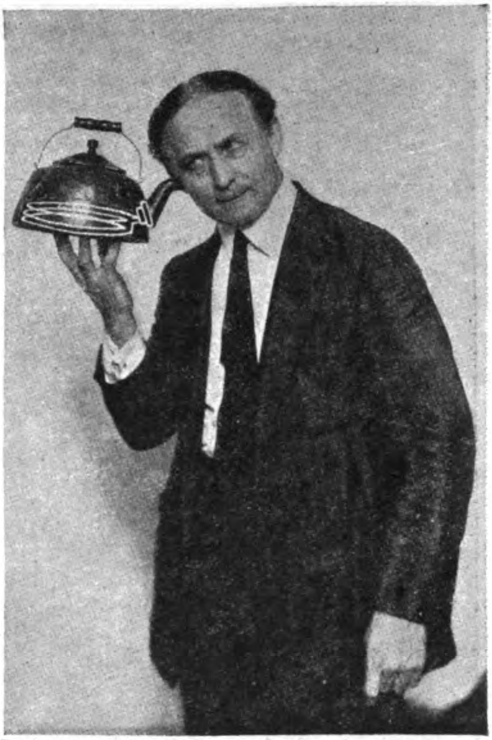
> In a small chamber in this house is seen a chest of white glass suspended from the ceiling by four little chains, which keep it perfectly separated from every other thing. This chest is transparent and penetrable to the eye in its whole extent. To one of its extremities is adapted an opaque tube or horn, by which a voice is heard; the voice appears to be that of a young girl, who replies distinctly to every question put to her.
>
> The impression of breathing and the heat of the air of respiration (impregnated with the odor of liquors which she has taken) are also perceived.
>
> I thought at first that this voice was that of a ventriloquist, and that it was the voice of him who showed the curiosity. But on the morrow my astonishment was extreme, when this pretended ventriloquist went out of the chamber with another, and, when I put new questions with a voice so low that I was not heard by any of the other spectators, to find that the replies were perfectly applicable and well articulated.
>
> If it be said that magnetical or electrical virtues are introduced for some purpose in the operation, we would ask how it happens by any of these virtues that the Young Invisible sees and names, without ever being deceived, the object which is held in the hollow of the hand, such as a piece of silver, the surface of which is held up to the orifice of the tube in such a manner that these objects cannot be perceived from any other point.
>
> We concluded that perhaps there was in the chest a really invisible girl, a dwarf much smaller than that of the King of Poland. This dwarf died in 1764. A wooden shoe served it a long time for a cradle. At six years old it was 15 inches high, at sixteen years it was 29 inches high. History speaks of a dwarf who at thirty years of age was only 18 inches high. It belonged to Queen Henrietta of France.
>
> If this is the fact, the dwarf must be only from twelve to fifteen inches in length and above five or six in thickness, this being all the space of the chest which cannot be seen, it being behind the communicating tube.
>
> The questions we put to the Invisible Girl and the replies which it made are as follows: *What age are you?* "Fourteen." *Where were you born?* "At Marseilles" (she has an accent absolutely provincial). *What is your name?* "Francoise." *Are you pretty?* "No." *Are you good?* "Yes, though sometimes ill-natured." *What is your position in this chest?* "I am reclining." *Do all the questions which are put to you disgust you?* "Never, but I am sometimes very much wearied."
>
> Although I could not discover the solution of the mystery, I would rather believe it to be a dwarf than any other thing.

This ancient and sceptical reporter would not believe the invention to be magical, but if he were living now, a good medium could make him think it spiritualistic. In reality the "Invisible Girl" was a full-grown woman.

A description of this trick is illuminating as illustrative of the methods of the fraudulent mediums even in those days. John Wyman, one of our well-known old time magicians, copied it from an early publication and put it in his book which was published in 1851. The device consisted of four upright posts, united by bars or nails at top and bottom. From the corner posts four wires bent in ogee form converged and terminated in a crown ornament. From these wires a hollow copper ball about one foot in diameter was suspended by four short, slender ribbons. The ball thus suspended was fitted with four copper trumpets pointing at right angles, with their bells directed to the side top-bars. The ball was simply hung in space by the ribbons, and trumpets were fixed in suspension along with the ball. The voice was conveyed to the flaring bells of two of the horns by a speaking tube concealed by one of the corner posts; then at right angles along the top bars to points directly at the center of two trumpet bells.

Questions were asked by spectators, who spoke into the bell of a trumpet which conveyed the message by the speaking tube to the lady assistant concealed in an adjoining room. Her answer was conveyed back by the same speaking tube. The voice was weak in volume and discernible only to those listening attentively at the four trumpets. The effect was that which might conceivably come from a small "Invisible Girl." The woman confederate was in a side room with a peep-hole through which she was able to see her dupes and make pert remarks about them. A signal system was also operated between the "person who attended the machine" and the concealed operator. The whole "machine" was so simple in construction that it appeared perfectly portable and movable to any part of the room.

It is interesting to note that as far back as 1784 mediums were using various means of transmitting the voice for mysterious effects. Radio has vastly increased their facilities.



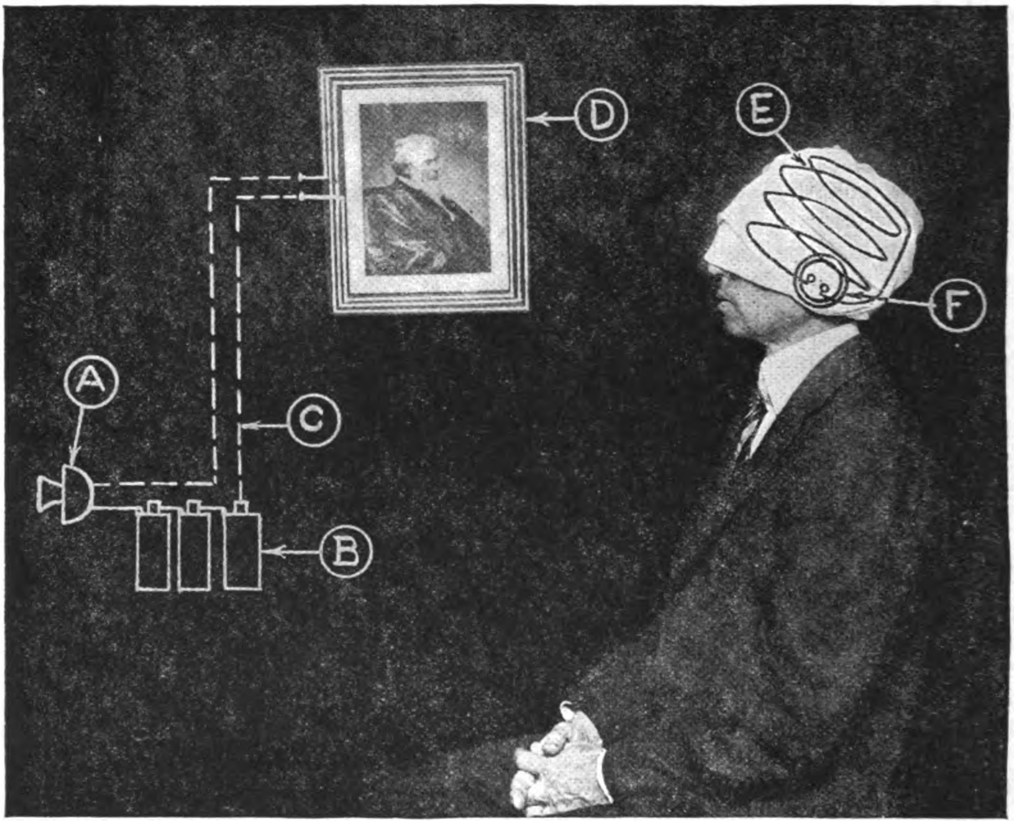
From a photograph made for POPULAR RADIO

THE SECRET OF THE KETTLE

The receiving coil hidden in false sides collects the energy sent out from a transmitting coil that may be several yards away, and this energy is converted into sound by the telephone receiver in the spout.

The fraudulent mediums today are merely using various adaptations of the "Invisible Girl." Instead of being in an adjoining room she is now so far away that she cannot hear the questions asked without the aid of a microphone concealed in the wall. Even at a considerable distance an opera glass, properly focused on the spot, serves the purpose of the peep-hole.

With an induction coil coupled in the circuit with her telephone transmitter and batteries, she now sends out strong enough impulses to affect the sensitive receiver with a loop aerial concealed inside the horn. This was, indeed, the first form of radio telephone. It employed the same principles of induction



From a photograph made for POPULAR RADIO

IN COMMUNION WITH THE "SPIRITS"—PLANTED IN ANOTHER ROOM

Still another variation of the inductive radio trick. (A) is the microphone into which the distant confederate talks; (B) are the batteries that furnish current over the concealed wires (C); (D) is the transmitting coil concealed in a picture frame; which transmits the energy to (E), the receiving coils, that are connected to (F) the telephone receiver over the medium's ears.

without wires as the modern complicated radio apparatus, and it worked almost as well over a distance of a hundred feet or more. The trick is a pretty one and would do credit to any magician, but it has fallen into the hands of unscrupulous psychic performers and consequently, because it is used for getting money under false representations, it should now be exposed.

With more modern apparatus and the pretense of spiritual communication, this simple illusion is now deceiving thousands and defiling the concept of life after death.

Perhaps you who are reading this article may attend the seance of a medium as clever as the woman who became nationally famous as a result of her work one evening in a western city. While she was in the midst of her communion with the shades of those present, she stopped short.

"I see a man murdered!" she exclaimed. Then she described a violent death scene, giving the name of the man and the address in the city where he was actually murdered a few minutes before she received the "spirit message." The newspapers confirmed her statements and later spread her fame throughout the country.

From that time on people paid ridiculous prices for her services—until she was exposed.

The secret of her spiritualistic demonstration was simple. A radio antenna in the sole of her shoe received impulses from a transmitting antenna in the rug upon which she stood, and conveyed them to a sensitive head phone hidden in a large bouquet of flowers on her shoulder. A reporter had telephoned the news of the murder to her confederate behind the scenes, who transmitted it by radio telephone. The receiver concealed in the flowers was not loud enough for the audience to hear, but when the medium leaned her head upon the flowers she could hear it distinctly.

Her feat was a blow she had been aiming at sceptics for some time. She had placed her reporters at police stations, hospitals and newspaper offices to wait for the news of a death by violence which would receive space in the papers.

You understand this particular type of medium now, and are sure you will not be fooled—but suppose you should meet the statistician-medium? She wears a phone over one ear and a complete aerial and receiving set is concealed beneath a heavy wig, or it is concealed in her hair.

She stands under a chandelier which hides the transmitting antenna, or perhaps walks near a picture from which the radio waves issue. If she is a good radio engineer, she may have a set so sensitive that she can place her transmitting antenna in another room. Your name rolls off her tongue, as soon as you enter. She tells you all about yourself, she seems to know as much about you as your intimate friends.

"Your mother will be here shortly," she remarks, casually, although you had not told her your mother was dead and that she was the one you wished most to be near.

Many a man has fallen a victim of such mediums, for he had no way of knowing that confederates had looked up his history while he was waiting for the interview, and telephoned it *via* radio. The medium offers proof that he or she has not left the room to receive information, and thereby he gains a few more gullible customers for his illicit traffic.

A few years ago, while going to Europe on the *Imperator,* I was asked to entertain with an informal seance. I had for my guests Theodore Roosevelt, Victor Herbert and other prominent men. Roosevelt wanted to know if I could tell him where he spent his last Christmas Day. I had a slate with a "spiritual" covering, and in a few moments, with the slate apparently before their eyes continuously, a map appeared upon it, made with a dozen colors of chalk. It indicated the exact spot where he had been on the "River of Doubt" and was a duplicate of the map he intended soon to publish in a book. The name of W. T. Stead, the English writer lost on the *Titanic,* was signed below the map; it was recognized as Stead's own signature. I had never seen the map and I was unacquainted with the signature.

"Is that really spirit writing?" Roosevelt asked with deep concern.

I am sure I could have won his confidence by this slight test. But I replied:

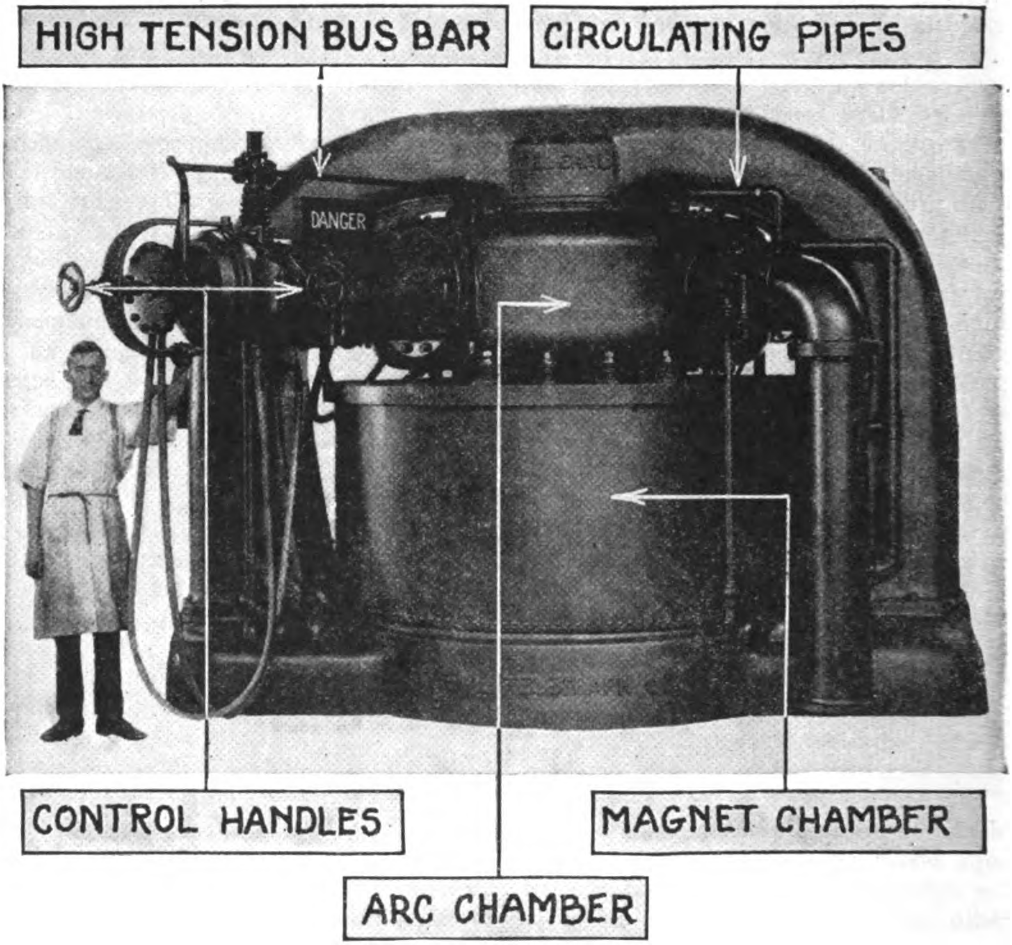
"No, I am simply a mysterious entertainer. Everything I do can be explained by natural means as illusions."

When it is so easy to deceive a highly developed mind, it is easier to fool ordinary people, and especially those who are anxious to believe.

In many instances self-hypnotism is the secret. The medium suggests things, catches the mind off guard, and the moment after it has been surprised he follows up with something else which carries the intelligence along even against the will.

Radio at present is the greatest aid to the fraud mediums, and they are sure to take advantage of every new development. I hope that spirits will talk to us through radio instruments some day, but I will prefer to hear such messages in a scientist's laboratory rather than through the presentations of unscrupulous mediums.

If there are mediums who are not fraudulent, I have yet to see them.



THE GRANDFATHER OF ARC TRANSMITTERS
This huge arc converter has long been used in trans-Atlantic telegraphy. It employs 1,000*K.W. of power—ranging from* 200 *to* 500 *times as much as is used for the new type of transmitter described in this article.*

THE NEW AND COMPACT

"Panel Arc Transmitter"

By CHARLES R. LENTZ

THE first arc transmitters designed for use on ships were cumbersome affairs, as every experienced marine radio operator knows. They occupied as much space as the first spark transmitters. The old arc chambers were designed on a generous scale, and with the auxiliary equipment just about filled the all too limited space of the vessel's radio cabin.

This unwieldy apparatus is now being replaced by a new and compact machine known as the panel transmitter, which can be included in a space 6 feet high on a floor space measuring only 24 by 20 inches for both the 2 K.W. and the 5 K.W. sizes.

This space may include the motor generator, but it does not provide for the water cooling tank or for the lightning switch.

As the result of practical and persistent experiment, an apparatus has been developed that is automatic in its operation; to switch from sending to receiving is but a matter of pressing a lever.

The auxiliaries and motor generator are designed for a 110-volt direct current supply, the usual source aboard ship, while the radio frequency portion is designed for an average ship antenna that has a capacity of approximately .002 mfd., with an average fundamental wave length of 440 meters and a high frequency resistance of 6 ohms at 600 meters.

Four wavelengths can be used by adjusting one switch, the transmitters generally being adjusted to 600, 1800, 2100 and 2400 meters. However, the 2 K.W. units have one high wavelength less than the 5 K.W., and provision is made for a 300-meter instead of the 2400. This is required by law.

For receiving with non-oscillating equipment, a modulating device is used which allows damped wave transmission at 300 and at 600 meters.

As shown in Figure 1, the upper panel is confined as far as possible to high frequency apparatus and leads. The open section in the center carries the arc chamber, the gas pressure regulator, the modulating device, the water pump and the carbon rotative mechanism; the two latter mechanisms are driven by the same motor. The lower control panel contains all the low tension and high tension direct current devices and leads.

Figure 2 shows a complete schematic wiring diagram of the transmitter and its auxiliaries. The ship's mains are brought to the panel through the main fused switch.

After the set is wired, and with the Send-Receive switch turned to "send," operations may proceed as follows:

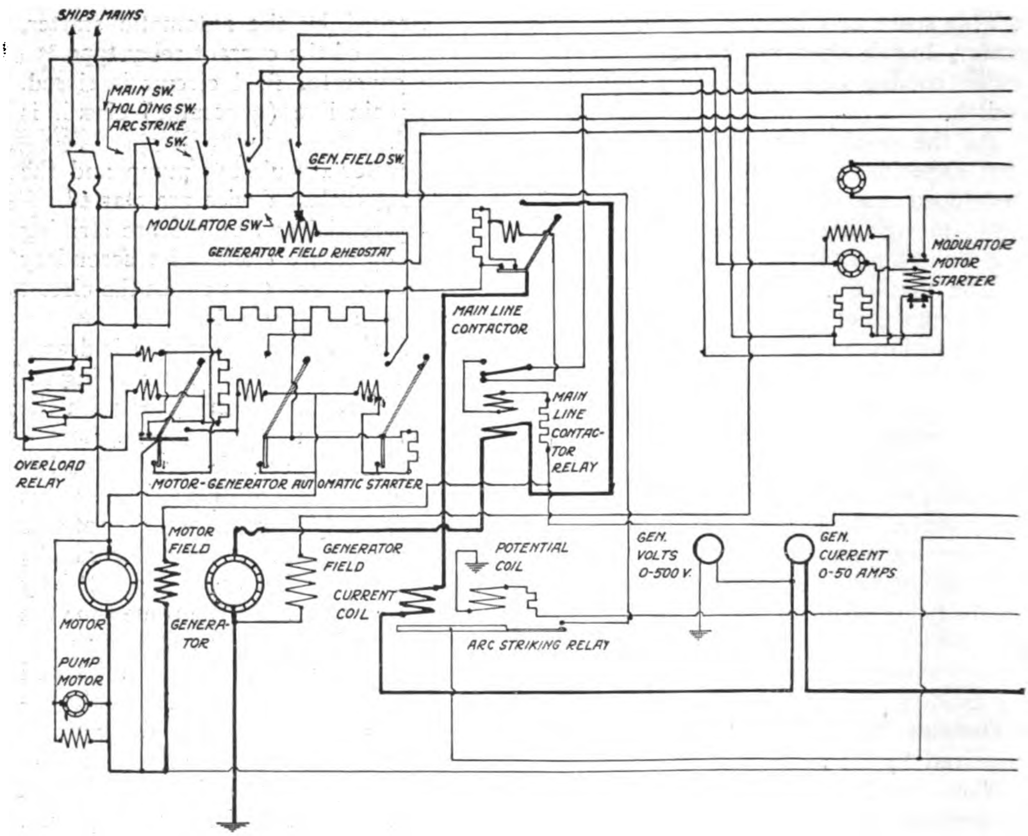
1. The motor generator is brought to full speed by the automatic starter, which is of the current relay type.
2. The generator field circuit is closed.
3. The main line (generator) circuit is closed.
4. The water circulating pump and the rotating carbon device are started.
5. The potential coil of the arc striking relay operates, closing its secondary contacts; this in turn closes the circuit to the arc striking solenoid.
6. Before the cathode (carbon) is drawn in to strike the anode, the starting resistor is connected in series with the arc and with the generator.
7. As soon as the arc is struck, the hydro-carbon magnetic needle valve automatically operates and the cathode slowly draws away from the anode, the proper action being regulated by an oil dash pot. At the same time the current coil of the arc striking relay predominates over the potential coil and the secondary contacts of the relay open again, allowing the cathode to withdraw from the anode. Again the starting resistor is shorted, and the arc is allowed to draw full power.

It is hardly necessary to describe the action in the high frequency circuit; the arc is of the Poulsen type and has been well covered in a number of text books.

In the 110-volt leads an overload relay is provided; when the current in the circuit is abnormal it flows through the current coil of the relay and this draws up an armature, breaking the circuit. The armature is held by a potential coil and cannot be released without disconnecting the ship's mains from the panel.

A relay similar to the overload relay is inserted in the generator leads, but in this case an overload opens the main line contactor (solenoid type), and this opens the positive side of the generator line.

The normal full load voltage of the 5 K.W. unit is 375 volts, variable by a generator field rheostat, and the normal full load current ranges from 12 to 15 amperes. Meters are provided with read-



ings in generator volts and amperes; the product of these two readings gives the arc input in watts.

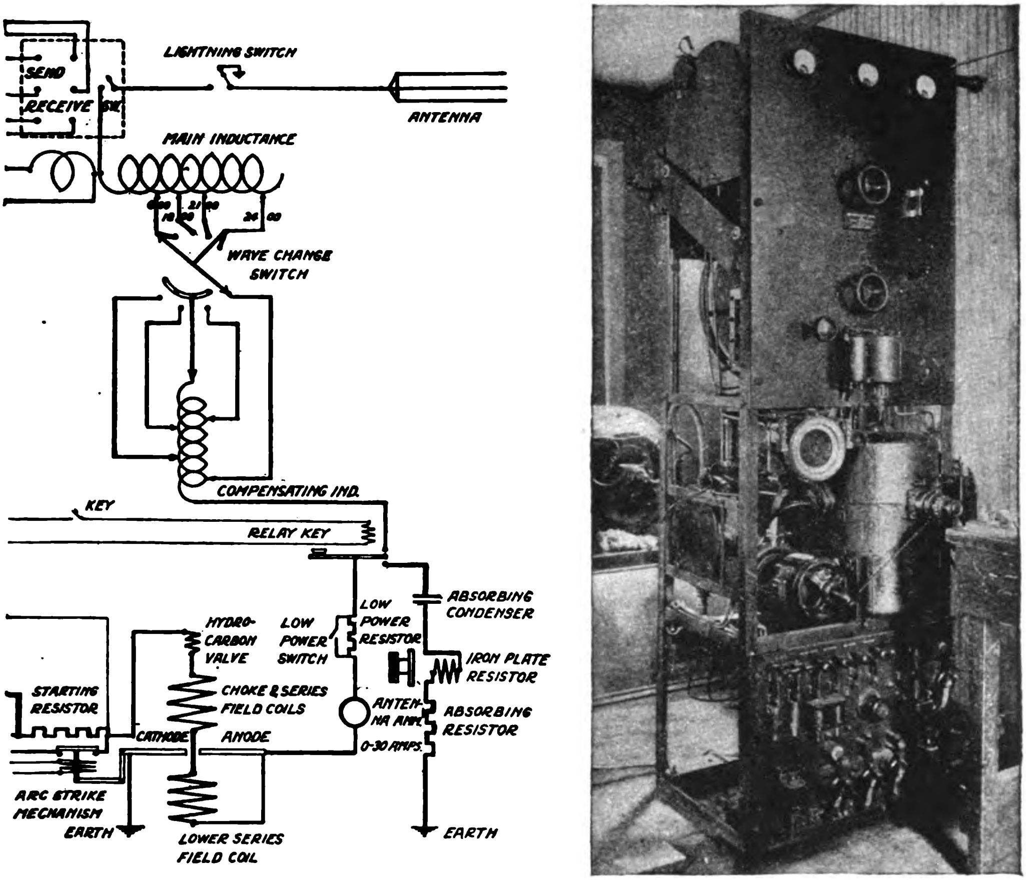
A radio frequency meter ranging from 0 to 30 amperes for the reading of antenna current is also provided. At 1800 meters a fair antenna current would be 18 amperes, assuming a 5-ohm high frequency resistance for the antenna. The antenna input would be of approximately 1620 watts, with an arc efficiency of approximately 30 percent.

The arc chamber is cast in two pieces. These are split about one-third of the way down, and in them are screwed the pole pieces. A watercooling duct of one complete turn is cast in the main chamber section.

The field coils are wound in four sections, one in the upper portion and three in the lower portion. They are wound with square cross-section asbestos-covered copper wire, and are connected in series. Additional insulation in the form of empire cloth insulation is provided between coils and chamber.

Connected directly with the chamber, and at ground potential, is the cathode, its distance from the anode, or arc distance, regulated with a control handle. The cathode holder can be removed instantly from the chamber, and a new carbon may be inserted without tools.

The anode is, of course, insulated from the chamber. It consists of a solid copper tip held by a large copper tube. Within the large tube is a smaller one, also of copper. The water from the cooling system enters through the small tube, plays directly on the solid tip and returns through the large tube. Then it goes through the one-turn duct in the chamber back to the cooling tank and from there to the circulating pump. During a period of continued use, carbon will collect in the arc chamber; this may be



WILL THIS NEW TYPE OF APPARATUS REPLACE THE SPARK TRANSMITTER?

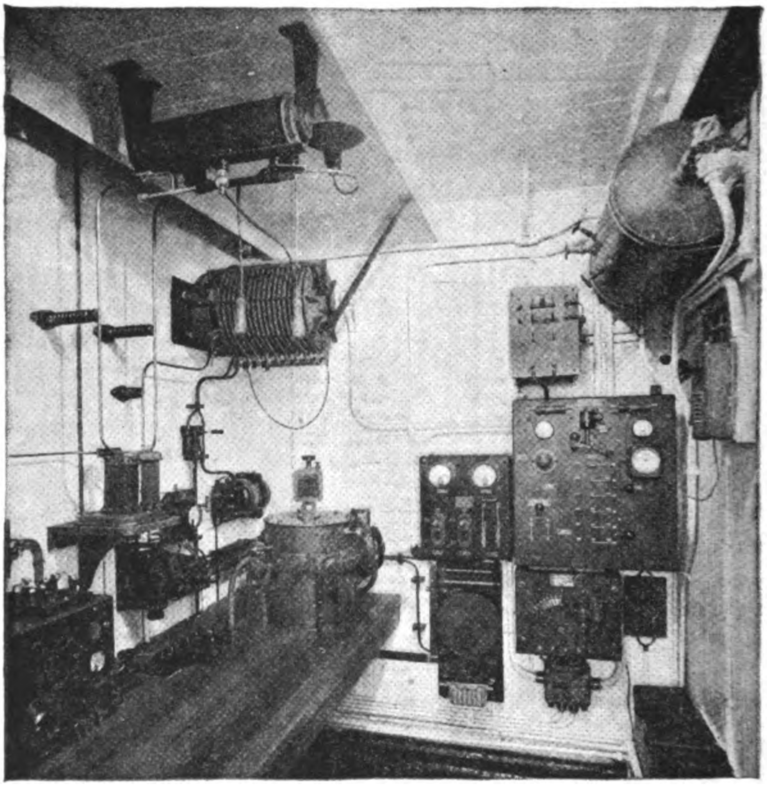
Diagram of apparatus wiring and picture of the new type of arc transmitter that bids fair to replace the troublesome spark transmitter now commonly used for ship-to-shore communication. The set can be used on low wavelengths and can transmit either continuous waves or modulated continuous waves by merely turning a switch. The modulated signal has a musical note of a frequency of 400 cycles a second. The set is capable of transmission over long distances.

cleaned out when the anode is removed.

Hydro-carbon is supplied to the arc by vaporizing alcohol; when the alcohol drips on the hot electrodes it automatically vaporizes. The pressure of the gas in the chamber is kept constant automatically by a regulator that has a diaphragm similar to that in an ordinary gas meter, and poppet valves are provided to prevent dangerous explosions. It has been found that when this gas is supplied to the arc it tends to keep the oscillations stable and allows the arc to handle a greater amount of power.

Unlike the high-powered arc transmitter, this set does not emit a "compensating wave." Signalling is accomplished by switching the anode terminal from an absorbing circuit to the antenna circuit, and when the key switches the anode lead the anode must always be connected with either or both of these circuits in order to sustain the arc.

The absorbing circuit consists of a condenser, a resistor, and an iron plate resistor, the complete circuit having approximately the same characteristics as the average antenna.



THE ORDINARY ARC TRANSMITTER INSTALLATION ON SHIPBOARD

The apparatus in this case is a 2 K.W. arc transmitter on the U. S. S. VULCAN. *The cabinet in the lower left corner contains the receiver; all the rest of the apparatus scattered about the cabin are the various parts of the arc equipment. Contrast this arrangement with the compact arrangement shown on page* 111.

The iron plate resistor is a variable unit, and it is possible to adjust the absorbing circuit so that it will draw exactly the same input as the antenna circuit. In other words, when signalling, the anode is first connected to the absorbing circuit and then to the antenna circuit; the arc input remains constant as indicated by the meters.

The transfer key is of the relay type and is remotely controlled by a single telegraph key at the operating table. An auxiliary handle protrudes through the panel so that the transfer key may be operated directly by hand in case of an emergency.

To change wavelengths with an arc transmitter it is only necessary to vary the amount of inductance in series with the antenna, or to vary the antenna constants. In this case the desired change is reached by inserting the proper amount of inductance in series with the antenna. The main inductance consists of a large Bakelite-Dilecto tube, wound with a heavy Litzendraht wire nearly 3/8 inch in diameter. The inductance is wound in sections and the sections are bank wound. Taps are taken off at every section.

It is apparent that fine wavelength adjustment is not possible when the inductance is varied by taps in every section, so a compensating inductance is provided. This consists of one flat spiral of strip copper, which can be varied by a handle on the front of the panel.

There is in the wavechange switch a total of eight positions for the four wavelengths, the extra position for each wavelength cuts in the compensating inductance for fine adjustment.

For example, if the desired wavelength is 2,400 meters, the wavechange switch is turned to the right "half" portion of 2,400 meters and the wavelength is measured and found to be 2,600 meters. Another section of inductance is cut out of the main inductance, increasing the frequency and the wavelength is then found to be 2,356 meters. Next, the compensating inductance is increased and the wavemeter read, the frequency decreasing until the wavelength is increased to exactly 2,400 meters. A permanent clip is then substituted for the variable contact and that contact is used again to adjust the other wavelengths.

To produce damped oscillations a modulator system is used. This consists of a few turns of heavy Litzendraht wire in inductive relation to the main inductance. These turns are periodically short-circuited by a special commutator which has a certain number of bars connected together. When current flows through the main inductance and these turns are shorted, the wavelength is decreased approximately 7½ percent. The speed of the commutator and the number of common bars were selected to give a 400-cycle note, while the resulting decrement is just enough to provide sharp tuning and yet insure being heard when transmitting.

If the operator wishes to reduce his power when he nears land, he may insert a 10-ohm resistance in series with his antenna, or he may reduce his arc input.

The water cooling tank has a sight level glass and controlling valves, and is usually mounted on the bulkhead with a casting provided for the purpose. Water connections are made with a special hot water hose, and in winter alcohol is mixed with the water to prevent freezing. Of course salt water can never be used as it would short-circuit the anode to the ground.

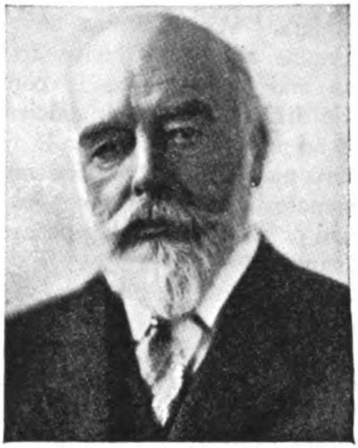
Excellent work has been done with these new transmitters. A 5 K.W. unit installed at Babylon, N. Y., when radiating only 8 amperes at 2,100 meters was reported by a tug stationed in the harbor at Hamilton, Bermuda. The tug had a standard Navy receiver with a two-stage amplifier and reported that the signals were readable ten feet from the phones.

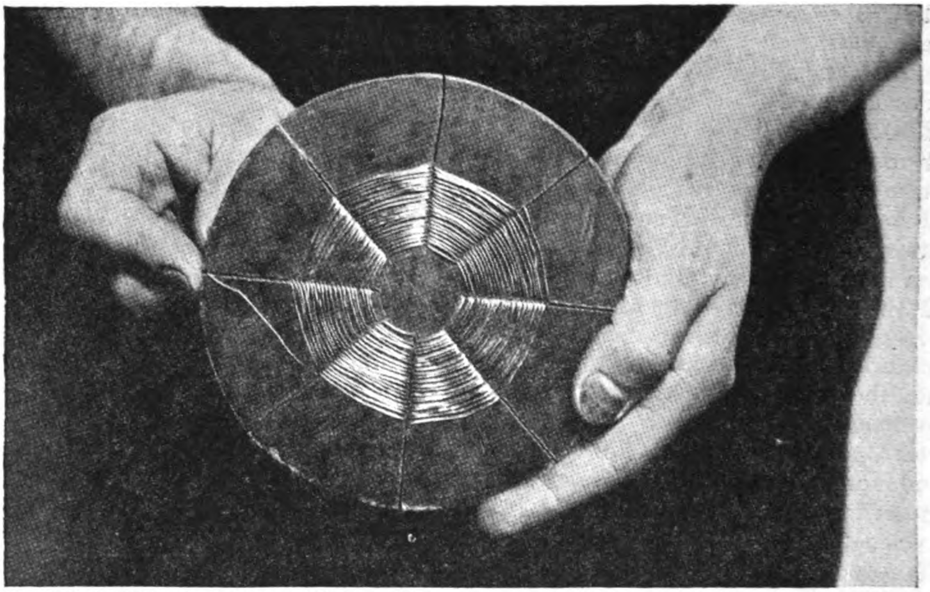
Another unit installed on the S. S. *Minnekarda* has worked the Cuxhaven Station at distances approximating 2000 miles. Cuxhaven uses a quenched spark gap.

The designers of the improved transmitter, Messrs. Shoemaker and Farrand, have made a distinct and valuable contribution in the field of nautical communication.

Are There No Ether Waves?

THE *now-famous article by the distinguished American physicist, Dr. Charles P. Steinmetz,* THERE ARE NO ETHER WAVES *(which was first published in* POPULAR RADIO *for July,* 1922) *has stirred up the proverbial hornets' nest in scientific circles both here and abroad. So seriously has it agitated the physicists of England, indeed, that they have turned to the greatest living English authority on ether to make a reply to Dr. Steinmetz—Sir Oliver Lodge, who has devoted the larger part of his life to a study of this subject. Sir Oliver's response will appear in our next issue—NOVEMBER.*





From a photograph made for POPULAR RADIO

THIS HOME-MADE COIL COSTS LESS THAN 50 CENTS

To make this device (sometimes called a "spider-web coil"), requires no special tools or unusual skill. This article gives complete instructions that every novice can understand.

How *to* Make a SPIDER-WEB TUNER

The Sixth of a Series of Practical Articles that Tell the Amateur How to Build His Own Apparatus

By A. HYATT VERRILL

THERE are many forms and types of loose-coupled coils and vario-couplers. While almost any form will serve as a tuning device for ordinary sets and while there is comparatively little difference in their efficiency if they are so arranged that equally fine adjustments may be made, yet for some types of regenerative sets a tuning device with a third or tickler coil may be used to good advantage.

To construct an ordinary vario-coupler with a rotor as a tickler is not a hard task, but the results obtained from home made instruments are not always all that is desired, largely because they are merely makeshift contrivances.

A type of vario-coupler which gives really excellent results, yet at the same time is simple and easy to make is composed of three flat, circular coils known as "spider-web" or "pancake" coils.

No great skill or experience is needed to make this and no unusual tools are required; the materials necessary are few and inexpensive; indeed, a first-rate coupler of this sort may be made at a cost of less than two dollars.

The only tools needed are a screwdriver, hack saw, ¼, ⅛, and 1/32 inch drills, a pair of compasses or dividers and a soldering set; in addition a set of screw taps and dies will prove useful. It is advisable for anyone who intends to make radio sets or instruments to purchase a set of taps and dies; they are not expensive and they soon pay for themselves many times over, especially if time is of any account.

For materials, you should have binding posts (such as may be taken from old dry batteries); some strip brass ½-inch wide, and ⅛-inch thick; some 1-inch by ⅛-inch brass screw-headed bolts with nuts and washers to fit; a couple of 2-inch by ¼-inch bolts of the same type; a supply of No. 22 or 24 cotton or silk-covered copper wire and enough Formica, Bakelite or other composition sheet ⅛-inch thick to make three discs each 6 inches in diameter.

First, draw a circle 6 inches in diameter on a sheet of heavy white paper or thin bristol board or cardboard. With your dividers or compasses mark off nine equal spaces around the circumference as shown in Figure 1. Then, with a straight edge, draw lines from each of these points to the centre of the circle, as shown in Figure 2. Next draw a second circle 2 inches in diameter as shown in Figure 3.

Now cut out the large circle and cut a slit from each of the marks along the radiating lines to the edge of the 2-inch circle, as in Figure 4. These slits need not be wide; 1/32 of an inch will do. Now, using this slotted circle as a template or pattern, place it upon the ⅛-inch sheet of composition sheet and with a sharp steel point or a pencil mark the outer circumference of the circle and each slot upon the composition sheet. Make three of these and then with your hack saw cut out the discs. If you have any difficulty in making good circles don't be discouraged, but try making the discs nine-sided by cutting straight across from one radiating mark to another, as shown by the dotted lines in Figure 4.

When the three discs are cut out, saw along each of the marks indicating the slots (making a single cut), and finally bore a ⅛-inch hole through the exact centre of each disc. Also, bore two 1/32-inch holes in each—one hole just inside the inner end of one of the slots and the other hole near the outer circumference close to a slot, as indicated in Figures 4 and 5. Thread one end of the wire through the inner hole on one disc, leaving six or eight inches free, fasten it with sealing wax and commence winding. Wind the wire from the hole up through a slot, across one of the

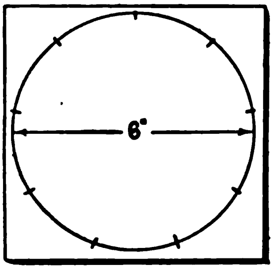


Fig.1

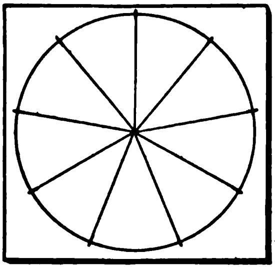


Fig.2

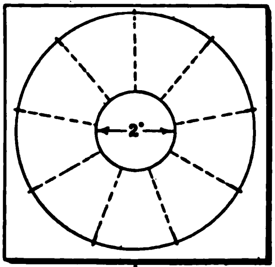


Fig.3

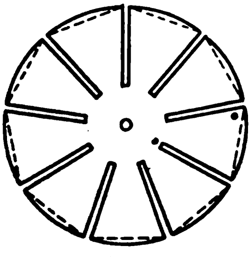


Fig.4

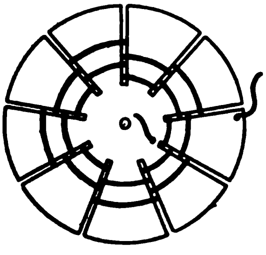


Fig.5

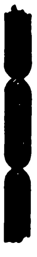


Fig.6

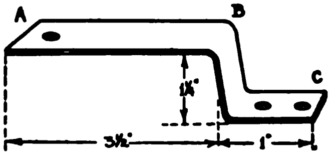


Fig. 7

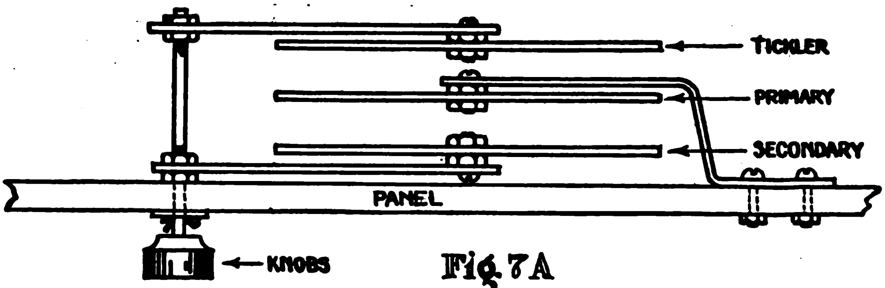


Fig. 7A

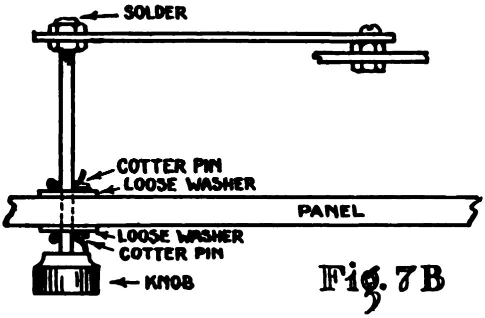


Fig. 7B

"blades" down through the next slot, across the next blade, up through the next slot, across and down again, and so on, as shown in Figure 5, as if you were weaving the bottom of a basket. In this way the wire, as you wind it on, will cross on itself in the slots at every turn, as shown in Figure 6.

Wind on about 30 turns on one disc, pass the wire through the small hole near the edge, fasten it with sealing wax and cut it off so as to leave at least 6 inches free. Then proceed to wind the next disc, and be sure to wind in the same direction as the first; but put about 50 turns on this one. Do the same with the third disc, putting on 80 turns of wire, and the discs are then ready to assemble. But remember, when I say 30, 50 or 80 turns I mean *complete* turns; the wire should pass the starting point 30, 50 and 80 times.

There are two ways of assembling these coils; the one you select will depend partly upon the way in which it is to be mounted and the space it is to occupy and partly upon your skill. If the coils are mounted or assembled in one way, two coils are movable past the third or fixed coil in the same plane, whereas, if they are mounted in the other way, they move back and forth or towards or away from the fixed coil. It makes little difference which method is used as far as efficiency is concerned, although personally I think the latter method is a little the better. It is a trifle more difficult to mount them in this way, however, and they also occupy a great deal more space. As the first way is the simpler, I will describe it first.

Take a strip of ½-inch by ⅛-inch brass and bend it in the form shown in Figure 7, making the distance from A to B 3½ inches and the distance from B to C about 1 inch. Bore two ⅛-inch holes in this short end and another ⅛-inch hole in the opposite end, as illustrated.

Now secure the disc with the fewest turns, or the primary coil, to the end (A) of this strip by means of a short ⅛-inch bolt. First slip the bolt through the hole in the strip, then screw a nut on tightly, then place the coil over the bolt and screw a second nut on; then file the bolt end down flush with the surface of the second nut as shown in Figure 7 C. Secure this strip bracket that holds the coil to the

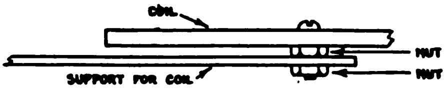


Fig. 7C

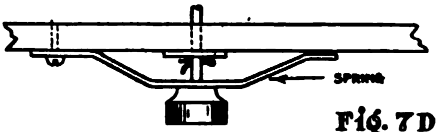


Fig. 7D

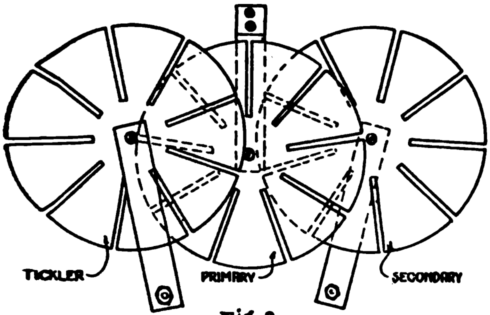


Fig. 8

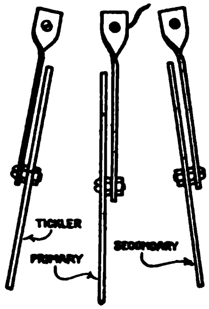


Fig. 9

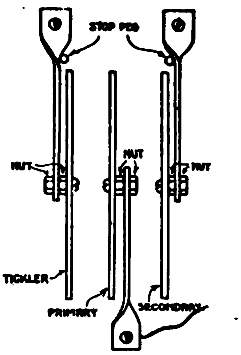


Fig. 10

panel or other support by means of two screws through the holes in the short end, as in Figure 7 A.

Now cut two more strips of the ½-inch by ⅛-inch brass, each 4½ inches long, and bore a ⅛-inch hole near one end of each strip and a ¼-inch hole through the other end of each. Fasten the other two coils to these strips—one coil to each strip—by means of screws and nuts through the ⅛-inch holes, exactly as you did with the first coil.

The next step is to mount these two movable coils in such a way that they may be swung into line with the fixed coil or swung away from it at will, as shown in Figure 8. The best way to do this is to hold one of the coils (the one with 50 turns of wire), against the primary or stationary coil and then mark where the ¼-inch hole comes on the panel. Then do the same with the coil that has 80 turns and bore holes through the panel where marked. As the 50 turn or secondary coil must swing between the primary and the panel and the tickler or 80 turn coil must swing the other side of the primary, it will be necessary to provide shafts of different lengths for the two. These may be long ¼-inch bolts secured to the strips fastened to the coils by means of two nuts (as shown in Figure 7 B), or they may be pieces of brass rod soldered to the strips. In this case you should place a washer both above and below the strip and solder washers, shaft and strip at one

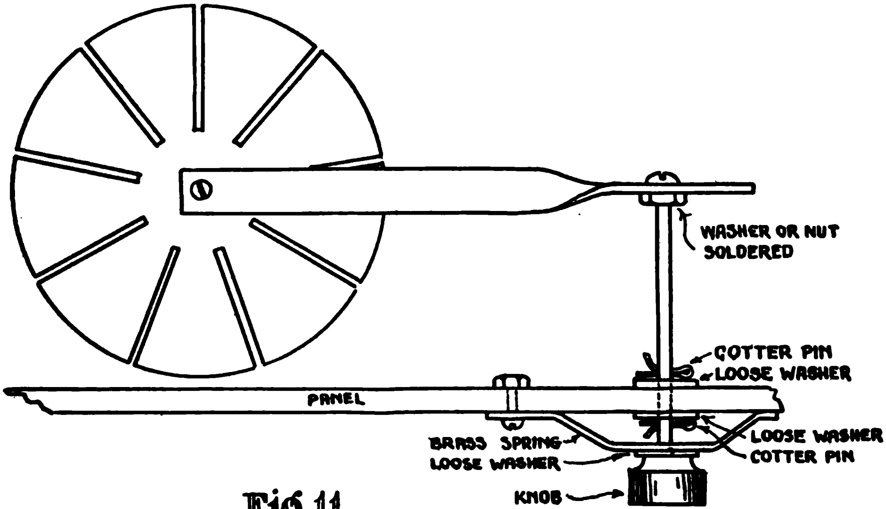


Fig. 11

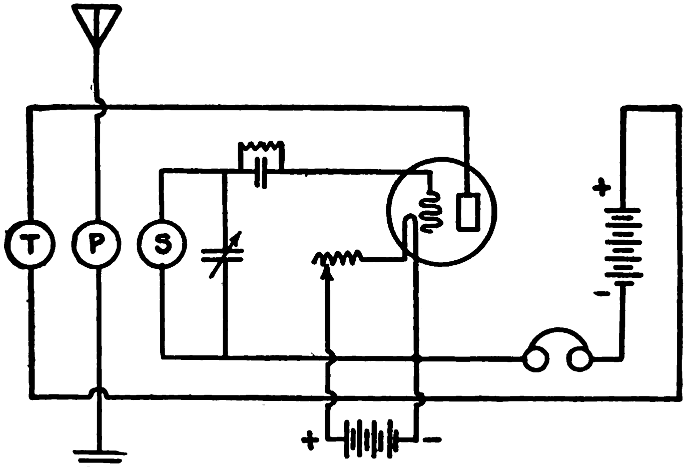


Fig. 12

time. If nuts are used it is also advisable to solder them in place so as to avoid any chance of their working loose. In fact all the nuts used in attaching strips to coils or to the panel should be soldered, as nuts and screws have a remarkable habit of working loose without apparent reason.

After the shaft is fastened to the strip it is an easy matter to pass it through the panel and arrange two loose washers, one on either side of the panel, secured either by small cotter-pins, or by soldering the washers to the shaft, so that the latter cannot move out and in. (See Figure 7 B). Then, when the coils are assembled in their proper positions, the rods should be cut off evenly on the outside of the panel and knobs of rubber or Bakelite attached to them.

You will find, however, that the weight of the coils and strips has a tendency to make the coils slip gradually out of position as set, even if the shafts fit tightly in the panel. This may be overcome by fastening a piece of spring brass to the panel and with an oblong hole in it through which the shaft passes. Then by forcing this down until there is quite a bit of pressure upon it and by fastening a washer or nut to the shaft against it (see Figures 7 D and 11), a steady pressure will be maintained upon the shaft and the coils will stay put.

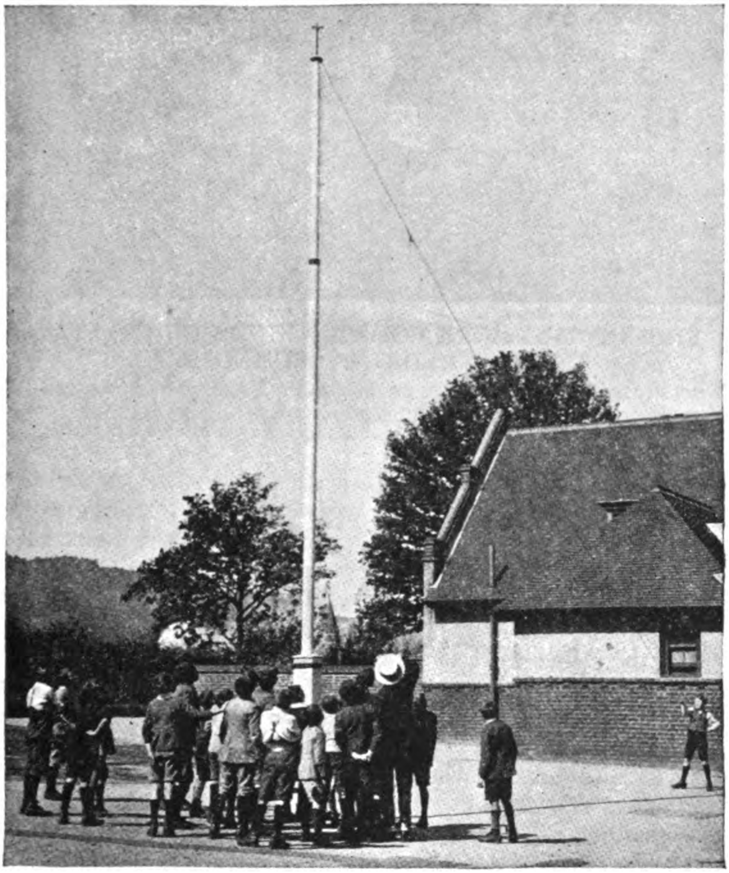
The other method of mounting the coils is shown in Figures 9, 10 and 11. The coils are secured to strips of brass as already described, but each strip is twisted at right angles near the free end as shown in Figures 10 and 11. They are then attached to the panel and are mounted exactly as described, the only difference being that they swing in a different way. The details of attaching the coils to the strips and of arranging the shafts and bearings, as well as the spring tension, are so plainly shown in Figure 11 that no description or explanation is needed.

Finally, when the coils are assembled lead the end wires to the binding posts, using flexible wires for the movable coils; and when you connect the set, follow the wiring shown in Figure 12.

When you first use this type of vario-coupler, place the coils so that all are in line, turn on the filament until it glows properly and adjust the variable condenser until you get the signals. Then move the coils slowly—first the secondary and last the tickler—until the interference disappears and the sounds you wish to hear come in clearly and distinctly. When the two coils are entirely away from the primary the shortest wavelengths are received; if all three are brought close together the longest wavelengths possible for the coils are brought in. In case you should find that you cannot tune down to the shorter wavelengths you wish to hear, you may cut down the wavelength by taking a few turns of wire from the coils or place a variable condenser in series with your aerial. If you do the latter you will secure a far greater range of wavelengths than by taking off turns of wire.

MAKE YOUR OWN VARIO-COUPLER!

¶ In the next issue the author of this series of "How to Make" articles, Mr. Verrill, will describe in detail how to build a novel form of vario-coupler—a form that is of special interest to amateurs because of its peculiar combination of efficiency and simplicity of construction.



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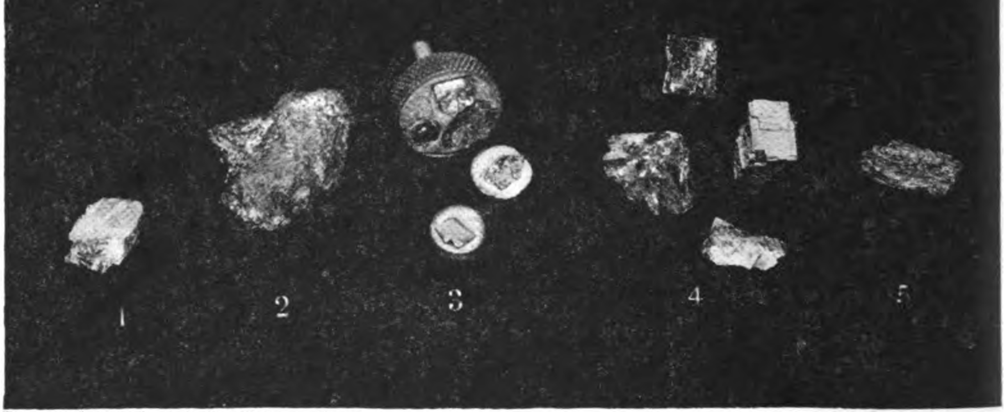
RADIO AS AN EDUCATIONAL FORCE IN THE SCHOOLS

It has been well said that "radio is making the United States a nation of scientists." Certainly no invention has so stirred the imagination of the American youth, or stimulated a more wholesome or more extensive study of electricity and of mechanics; even in England, where radio is but little known among amateurs, the subject is being taken up in the schools. What the schools are doing with radio will be told in succeeding issues of POPULAR RADIO.

How *the* Crystal Detector Detects

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 5

By LAURENCE M. COCKADAY, R. E.



From a photograph made for POPULAR RADIO

FIVE OF THE MORE COMMON KINDS OF CRYSTALS USED IN RADIO RECEIVING SETS

No. 1 is a piece of pyrites; No. 2 is molibdenite; No. 3 shows three bits of crystal mounted in Woods metal settings for commercial use; No. 4 shows four pieces of the familiar galena crystal, and No. 5 is a silicon crystal.

THE antenna forms the means of transmitting energy through space without the use of wires; it is also the means of collecting this energy at a receiving station and reconverting it into electricity. The inductance, or coil, and the condenser are the means used for tuning the circuits which are connected to the antenna, so that the electric currents induced in the antenna may be led through these circuits to do work in producing some tangible result that may be used for signalling. In both radio telegraphy and radio telephony this result is sound.

The ordinary telephone receiver is a device that will change electricity into sound waves.

"But why," asks the beginner in radio, "do we need the detector at all when we have such a device as a telephone receiver, which is designed for this very purpose, to change electric currents into sound waves?"

It is true that this point is hard to fathom out by oneself without a little study.

In the first article of this series*, we delved a bit into the theory of wave motions and learned that sound waves had a certain frequency range. If a flexible reed were to be started into vibration, and the speed of vibration or frequency be increased, at first a low note is heard; as the frequency is increased this note steadily mounts upwards in pitch until it becomes a shrill whistle; finally the note becomes so high that we can no longer hear it. In other words, the tone goes up beyond the range of detection by the human ear.

---

* *See* POPULAR RADIO *for May,* 1922.

The telephone receiver is designed to work on frequencies that the ear *can* detect. Like the human ear, its diaphragm will not respond to vibrations that are too high in frequency. Even if a special receiver were to be designed that would respond to these frequencies, we would not have solved our problem, for the ear would not detect them.

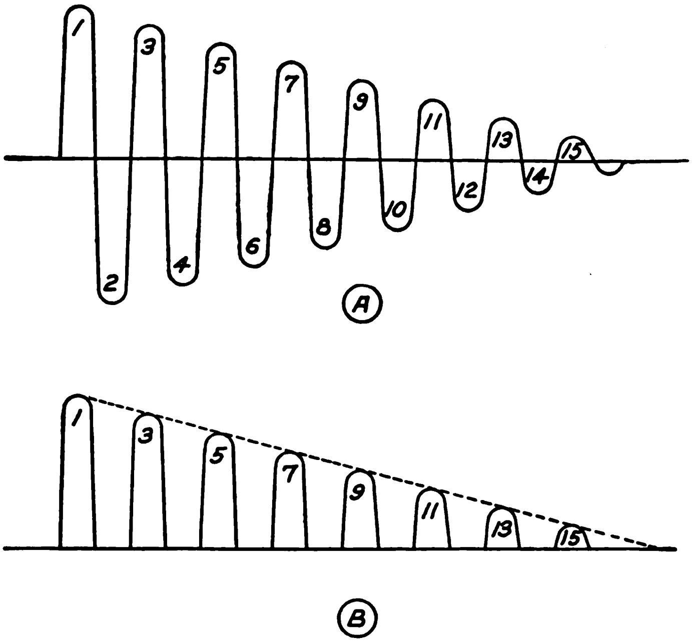
The electric currents that are used in radio are of a very high frequency—as many as millions a second. Now we see that this is the reason that they would not work the receivers in a radio set, and some other device would have to be used to lower the frequency of these currents before they could be used to energize the receivers and produce audible sounds.

The telephones used for radio reception are generally designed to operate with maximum efficiency at a frequency of about 800 cycles a second; if a current of a frequency of over several thousand a second is led through the windings, they produce no sounds, as the diaphragm cannot move quick enough.

The diagram, Figure A, shows a series of high-frequency electrical oscillations such as are used in radio telegraphy. Notice that these follow each other, reversing direction after each impulse; first an impulse in one direction (numbered 1) which we may call a positive impulse, and then an impulse in a reverse direction (numbered 2) which is a negative impulse. These follow each other in such rapid succession that if they passed through the telephone they would produce no results, for before the diaphragm would have time to get started into motion in one direction, the second opposite impulse would be tending to prevent its motion, and so on indefinitely.

Here is where the detector comes to the rescue.

It was discovered some time ago that



RADIO IMPULSES BEFORE AND AFTER RECTIFICATION

The top diagram, A, shows incoming high-frequency impulses before they are rectified, and the lower diagram, B, shows the same impulses after they have been rectified by the crystal. Note that only the impulses in one direction remain; the others are choked back.

certain mineral crystals offered a great resistance to electric currents when these currents were led through them in one direction, but offered small resistance to currents that flowed through them in the opposite direction. This action is somewhat similar to the action that takes place in the valve of an automobile tire. Air may be pumped into the tire through the valve, but air may not pass out of the tire through the valve. The air may pass in one direction through the valve.

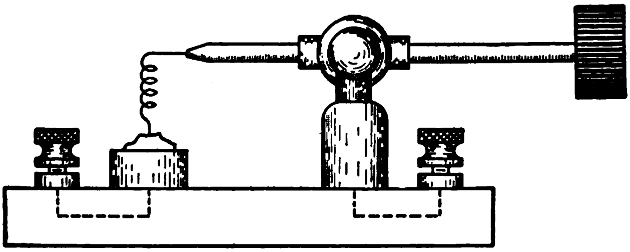
Somewhat the same thing happens with the crystal detector. The electric currents may pass in the one direction, but not in the other.

If a high frequency current such as shown in Figure A should be led through a crystal of this kind, only one-half the impulses would get through; those that flow in one direction would pass while those that flow in the other would not. This would allow a series of positive impulses (1, 3, 5, 7 and upward) to flow through the telephones, as shown in Figure B. These impulses flowing through the telephones in such rapid succession, and all of the same polarity, would act on the diaphragm as one large impulse such as indicated by the dotted line in Figure B. This impulse, extending over a much greater time than the smaller period impulses, would pull the diaphragm in one direction and this would make one single sound impulse. If a series of high frequency oscillations are generated in groups of a definite audio frequency at a distant transmitter and are received and "rectified" by the crystal as thus described, they will reproduce the same sounds in the receiving telephones as those produced at the transmitter. In this way the crystal prepares the received energy so that it can be used to work the telephones and our present day telegraphy and telephony is thus made possible.

Unfortunately, however, crystals do not have this rectifying quality throughout the entire surface; they have it only in spots, and it sometimes is an aggravating task to find the sensitive spot. For this purpose the crystal is usually mounted in a metallic cup, which is connected to a binding post; and a spring wire attached to an exploring arm, which is mounted on a universal joint, is used for finding the sensitive spot on the crystal. This arm is connected to another binding post. A detector stand of this type is shown in Figure C.

The knob on the end of the arm is slowly wiggled around until the spring point comes into contact with a sensitive spot on the crystal, when signals will be heard in the telephones—providing, of course, that some station is sending and the receiving apparatus is tuned to the particular wavelength that the station is sending out on. When we are trying to "set" or "adjust" our detector, if our set is not tuned to any other station's transmitting wavelength, we would never know if the detector were in adjustment or not.

A device which is of great help in adjusting a detector is known as a buzzer test, and this consists of a high tone buz-



THE ORDINARY CRYSTAL DETECTOR

FIGURE C: *The type of detectors generally known to radio amateurs. It consists of a cup for holding the crystal and an adjustable arm and spiral spring for finding the sensitive spot.*

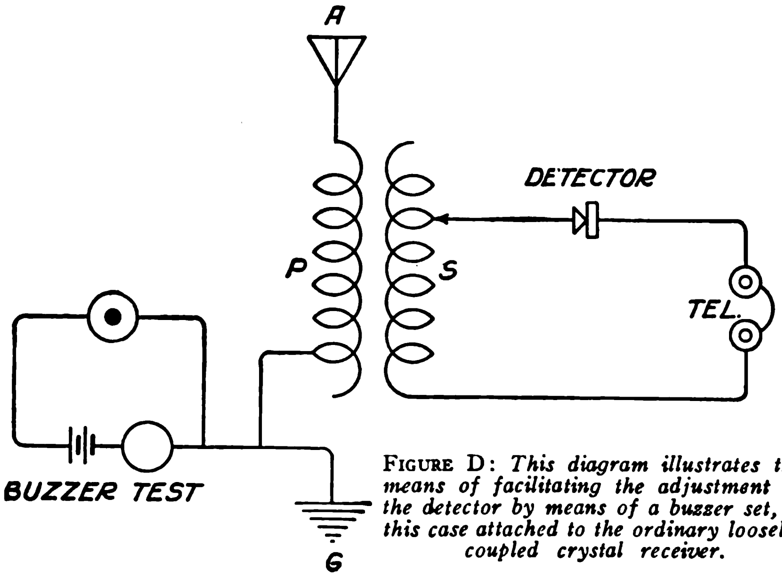


FIGURE D: *This diagram illustrates the means of facilitating the adjustment of the detector by means of a buzzer set, in this case attached to the ordinary loosely-coupled crystal receiver.*

zer connected in series with a dry battery and a push button. When this device is connected up (as shown in Figure D) with a receiving set that employs a tuning device (in this case a loose coupler, P and S) and a crystal detector and a pair of telephones, and the push-button is held down with one hand while the detector is adjusted with the other until the buzz is heard distinctly in the telephones, the detector is set without bothering about tuning for any outside signals; when thus set, the push-button may be released and the set be tuned with the assurance that if any one is sending within range of the receiver his signals will be heard.

There are numerous crystals that possess these rectifying characteristics to a greater or lesser degree, and these may be obtained at almost any of the regular radio stores.

Thus we can readily see that the detector is necessary in a receiving set after all, and can more fully understand what we are accomplishing when we adjust the little spring on our set that sometimes causes us so much worry and sometimes brings forth bursts of heated language.

In the next article we will take up the study of the vacuum tube as a detector, and point out its points of superiority over the crystal.

How to Perform Tricks with High Frequency Current

DO you know that you can send a million volts through your body without injury—provided you use a low current? How to entertain your friends with spectacular but harmless demonstrations of the phenomena of electricity will be told in POPULAR RADIO—*in a near issue.*

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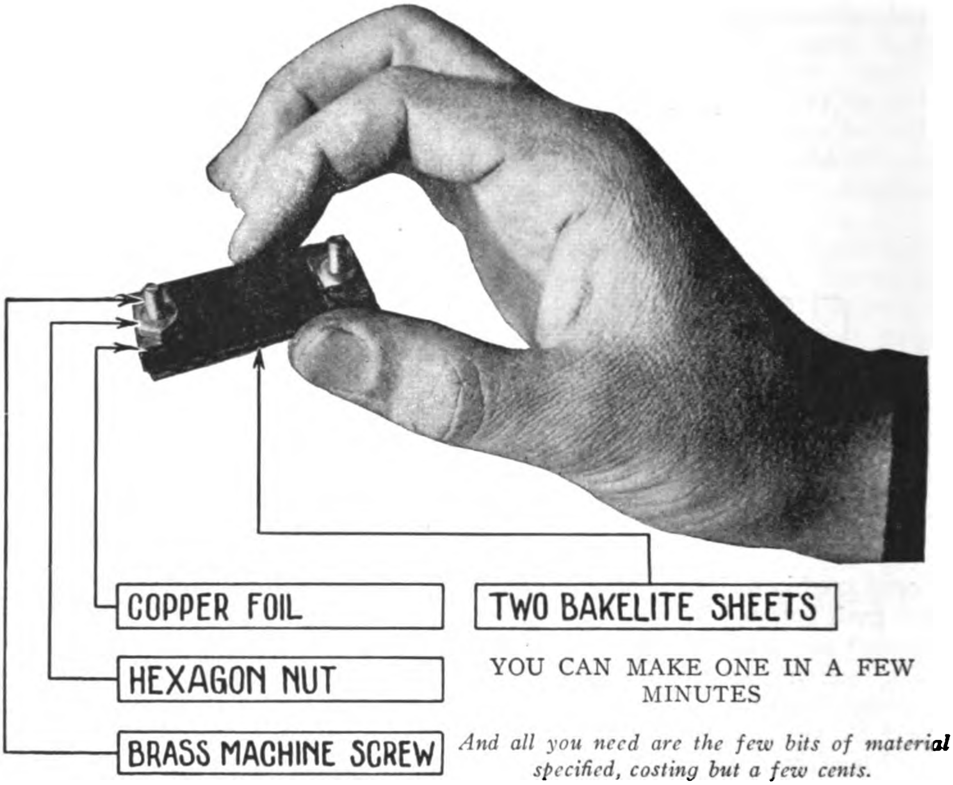


YOU CAN MAKE ONE IN A FEW MINUTES

And all you need are the few bits of material specified, costing but a few cents.

How *to* Make Your Own Grid Condenser

By RICHARD LORD

ONE of the most important parts of a receiving set—and one that is usually neglected by the amateur who builds his own set—is the grid condenser. The usual practice is to build the rest of the set, the vario coupler and the variometers; mount the rheostats and tube sockets, and then look around for some tinfoil and waxed paper. The tinfoil is usually cut into a couple of square pieces of almost any size that the builder happens to prefer at that instant. A hurry up job is then done in the insulation of the two pieces of tinfoil with a sheet of the waxed paper, and two wires joined to the two plates; the so-called "grid condenser" is then stuck into the set to see how it works. If any signals are heard the builder considers himself lucky. If, on the other hand, nothing at all is heard, he tries again and makes another condenser, hoping for better luck next time.

All the luck or element of chance may be taken out of the process of making a grid condenser by following the directions here given; the builder will then have a grid condenser that cannot be improved upon even if he were to buy one in a store.

Obtain a strip of thin copper, about three mills thick, and cut two strips 2 inches long and ¼ inch wide. Then get a piece of mica sheet and split it to a thickness of approximately .002 (two one-thousandths) of an inch. Any machine shop will be glad to measure the mica for you with a micrometer and will help you split it to get the right thickness for a small sum.

Cut the sheet to a size of ¾ inch wide by 2 inches long. Then obtain two pieces of sheet bakelite ⅛ inch thick, and cut it into two sheets of the same area as the mica sheet. Next obtain two 8-32 brass machine screws, round headed, and four nuts and washers to fit.

The next job is to assemble the parts properly. Place the sheet of mica between the two sheets of bakelite and bore two holes large enough to pass the two screws so that they fit snugly in the holes.

The holes should be bored through all the sheets at once and should be spaced ¼ inch from each end of the sheets. The mica is then taken out from between the two sheets of bakelite and the two strips of copper are placed one on each side of

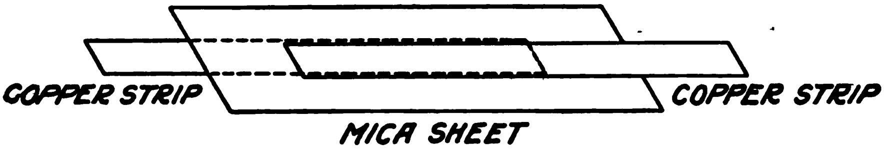


FIGURE 1 (at top)

How the copper sheets should be placed—one sheet on each side of the mica.

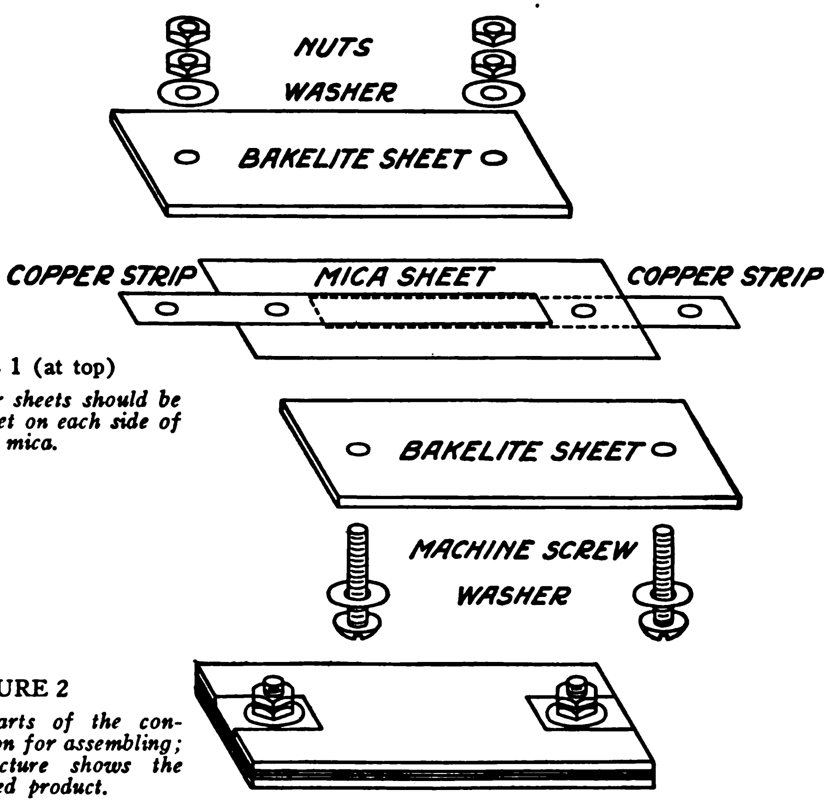


FIGURE 2

The various parts of the condenser in position for assembling; the bottom picture shows the completed product.

the mica. One-half inch of the copper strips sticking out beyond the mica leaves the two sheets of copper overlapping one inch in the middle, but separated by the mica as shown in Figure 1. Place the two sheets of bakelite carefully, one on each side of the other parts and bend the two flaps of copper over on one side, and, while holding them in a clamp, bore the holes so that the screws can be inserted through the whole and the nuts and washers tightened down so that the condenser will be properly held together. In this way the two outside strips of copper make contact with the two screws which act as terminals.

The parts about to be assembled, and the complete condenser are shown in Figure 2.

After the condenser is assembled, fasten two wires, one to each terminal, by screwing down an additional nut on each terminal.

The condenser may be made moistureproof by immersing it in a bath of melted paraffine. Do not use any solder or soldering flux on the condenser.

DON'TS

Don't try to transmit without a license.

* *

Don't forget that tube sets are far more efficient than crystal sets.

* *

Don't handle the crystals of your set.

* *

Don't try to get a fine adjustment while touching the detector with bare hands.

* *

Don't fail to make good connections.

* *

Don't forget to scrape off the insulation and have wires bright before making connections.

* *

Don't cover joints with adhesive tape; use "spaghetti' or varnish cambric tubing wherever possible.

* *

Don't oil any portion of a set.

* *

Don't blame your set until you are sure it is not your fault that something is wrong.

* *

Don't be discouraged if the first galena crystal you try is not very sensitive. Try a number of pieces.

Don't connect the lightning-switch to an inside ground.

* *

Don't use iron for an aerial.

* *

Don't forget to keep the aerial and lead-in insulated from all other objects.

* *

Don't expect to get good results with an aerial less than 100 feet long or low down among other buildings.

* *

Don't run your aerial parallel with electrical wires, elevated tracks or steel bridges.

* *

Don't forget that a good ground is necessary.

* *

Don't try to use your instruments just before, just after, or during a thunder storm.

* *

Don't rush blindly at the set and turn knobs and handles hit or miss if anything goes wrong. Be calm and patient and go slowly. Haste makes waste in radio as in all things.

Harris & Ewing

THE KEY AND ITS INVENTOR

H. E. Hallborg, who is shown above, shares the honor of inventing this practical little time-saver with H. R. Miller—both of the Navy Department.

An Ingenious "BREAK-IN KEY"

A New Time-Saving Device That Enables the Operator at the Transmitting Station To Listen-In On the Receiving Station While He Is Carrying on Communication

By S. R. WINTERS

AN automatic break-key, designed by H. R. Miller and H. E. Hallborg, radio engineers of the Bureau of Engineering, United States Navy Department, greatly simplifies the interception of amplified wireless signals when messages are being transmitted and received aboard sea-going vessels. The radio operator, by the use of this new break-key, can interrupt the progress of a message at any time and ask the sender to repeat a word or sentence without waiting until the entire message has been sent. This interrupting mechanism switches from transmitting to receiving by the use of a novel break-key. The use of a break-key with a crystal detector has been found impractical, and the vacuum tube detector has been even more defiant until the radio engineers of the Navy Department pledged themselves to patient research.

The radio operator's head telephone winding is normally energized by both a constant direct current flowing in the plate circuit and by the signal current pulses of audio frequency. The latter are relatively feeble when produced by distant signal, but exceedingly strong when having their origin in the local transmitter. Hence, solution of the problem resolved itself in a search of means for shunting-out of the phones, the heavy artillery of the impulses of local sending, and a removal of the shunting device without affecting the constant plate current of the tube. Achievement of this condition, it was agreed, would make the head telephone immediately responsive for reception.

A low reactance telephone shunting condenser offered a simple and effective solution. The scientific reasoning leading up to this conclusion follows: The normal frequency of a signal is from 500 to 1,000 impulses to the second. A condenser of two microfarads capacity has a reactance of 500 cycles of 159 ohms. The reactance of a pair of head telephones to a like frequency approximates 22,000 ohms. Consequently, the condenser shunt deprives the telephones of 99.3 per-cent of its pulse current and even the powerful radiation of the local transmitter is rendered inaudible. At the same time, the condenser shunt exercises no influence upon the steady plate current of the tube, since a condenser forms an open circuit to direct current. The plate current is, therefore, susceptible to impression by the distant signal voltage at once after the local radiation is cut off and the telephone shunting condenser removed. Decrease in the telephone shunt capacity value permits the radio operator to hear his own sending to any audibility desired.

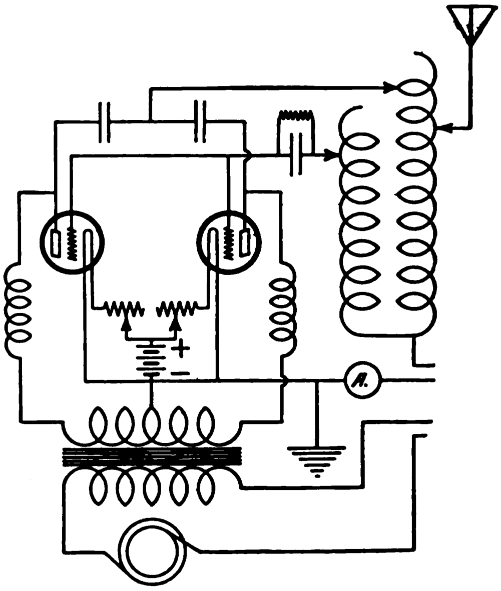
The new break-key involves the use of at least three sets of contacts; a pair to control the transmitting equipment, another pair to shunt the local radiation out of the receiving equipment, and still another pair to shunt the telephones.

This method of breaking in is of practical application and is noiseless and positive even when functioning with amplified radio signals. In actual use the telephone shunting condenser contact is closed first, the receiver contact is next in order, and the antenna contact is last. The contacts are opened in the reverse order.

Breaking in with four stages of audio frequency amplification is feasible with this system. The Hallborg-Miller progeny has been installed on two dozen vessels, and will soon be readily available for commercial use.

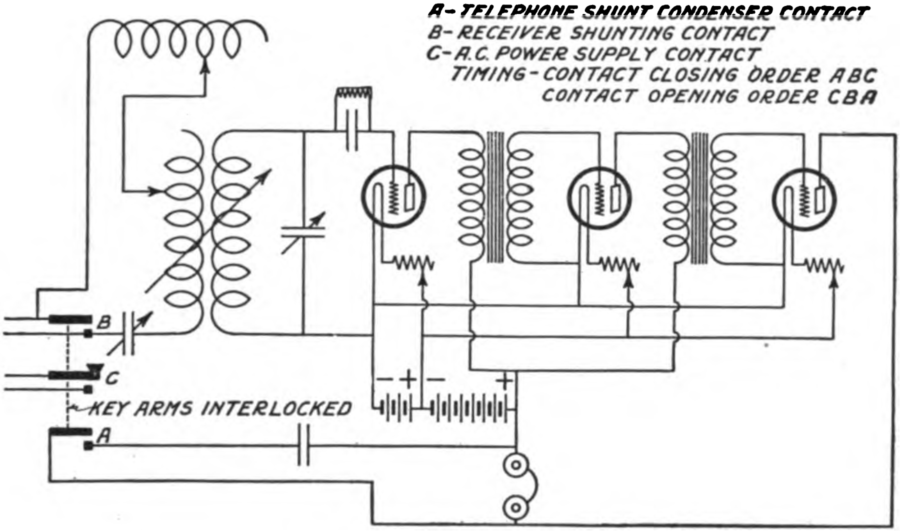
The electrical connections of the newly-devised radio interruption system in an alternating current tube transmitter circuit with receiver arranged for two stages of audio frequency amplification are explained in Figure 1. The hand break-key is so constructed as to be fitted with adjustable timing screws. The key is equipped with balance springs, a provision serving to neutralize the inertia of the auxiliary contactors. The operator is thus relieved of undue fatigue when fingering the key.

It is not unreasonable to expect that with the universal application of this device to ocean-traveling vessels that radio communication and its traffic burdens will be handled with the same facility and certainty on the waters as on land. The troublesome task of changing the antenna switch from the sending to the receiving position is no longer necessary.



The break-key has long been a common word with sea-going radio operators, although the prevailing arrangement hardly justified the term. When radiotelegraphy and radio-telephony were popularly represented as an antenna, a sending key, an open spark gap, and the crackling on board ship when a message was in progress, the radio operator clamored for a successful break-key. He was usually recruited from the railroad telegraph station or commercial land-wire telegraph staff, and was picturesquely described as a brass pounder.

His previous experience had made him a master of the simplex, duplex, and quadruplex forms of communication. He complained when compelled to operate a switch necessitating a change from sending to receiving positions a score or more times while clearing traffic of a few hundred words. The "brass pounder" found himself possessed with the insatiable wish to "break" the wireless sending operator when a letter or word or two


A- TELEPHONE SHUNT CONDENSER CONTACT
B- RECEIVER SHUNTING CONTACT
C- A.C. POWER SUPPLY CONTACT
TIMING- CONTACT CLOSING ORDER ABC
CONTACT OPENING ORDER CBA
B
C
KEY ARMS INTERLOCKED
A
–
+
–
+

THE CIRCUIT USED WITH THE "BREAK KEY"

This is the hook-up employed for connecting an alternating current modulated C. W. transmitter and a two-stage audio frequency amplifier and receiver by means of the special break key. A straight C. W. transmitter and a regenerative receiver may be similarly connected.

was brought into question as to its correct reception.

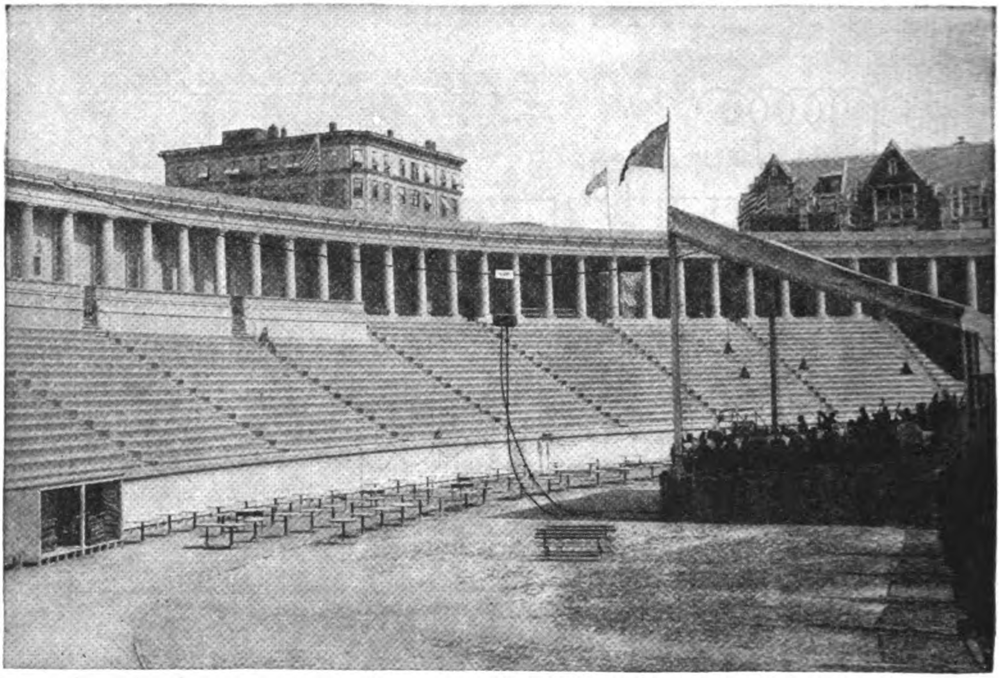
The multiplied troubles of the radio operator on board ship, and persistent complaints to the superintendent, have hurried the development of the break-key. The name was a misfit for the early devices with their multitude of levers, wires and contacts. The delicacy of the equipment was responsible for periodic instruction from the company engineers not to tamper with the outfit.

The "gadget," as it was disrespectfully called, sputtered and flashed at the contacts, and the noises circulating in the telephones further tried the patience of the operator. Messages were received with uncertainty and traffic was frequently congested.

Such is the story of the break-key as applied in the day of the supremacy of the crystal detector. The vacuum tube detector and multi-stage vacuum tube amplifier further aggravated the trouble. The recent invention, however, promises in theory to help the radio operator, whose duties are constantly increasing as the radio art develops.

How *to* Add a Tube *to* Your Crystal Receiving Set

So widespread has become the interest of radio fans in the hand-made crystal receiving set which was developed last spring by the Bureau of Standards in Washington (and described in detail in the May issue of Popular Radio) that a demand has been created for information for improving and developing this apparatus. So Uncle Sam has just produced another set of specifications that tells how to substitute a tube detector for the crystal detector. They will be published with special diagrams and photographs made especially for Popular Radio—in next month's issue.



From a photograph made for POPULAR RADIO

THE EAR OF A MILLION LISTENERS

Suspended twenty-five feet above the ground and about the same distance in front of the concert platform, this microphone (actually only four inches in diameter and four inches long), served to transmit the music over an area estimated at over 2,000,000 square miles.

The Radio Symphony

How the Music of a Great Orchestra Was Played in One State, Broadcast from Another State and Brought Within the Hearing of the People of Half a Continent

ON page 83 of this issue of POPULAR RADIO General Squier writes, in referring to the coming influence of broadcasting upon civilization: "Soon we will be measuring culture by watts."

The General's prophecy had hardly been written when a significant demonstration was made of the possibilities that are rapidly being developed for bringing the world's greatest music to the world's greatest audience—the radio fans of America. For the first time in history the music of one of the greatest of orchestras, the New York Philharmonic, of eighty-five pieces, was transmitted by special wire from the City College Stadium in New York to a distant broadcasting station and sent out by radio to probably the biggest number of auditors that have ever listened in on a musical program. Remarkable as this experiment proved to be in itself, it is still more remarkable in what it presages. No longer is it inconceivable that the world's best music and the world's foremost citizens may literally be brought to the Little Red School House, even in the remote wilderness. Shortly culture may indeed be "measured by watts."

This enterprise was initiated by POPULAR RADIO in accord with its policy not only to serve the interests of the radio fans of this country but also to demonstrate the possibilities of extending radio into larger fields of public usefulness and thus serve the cause of humanity.

THE world's greatest concerts, literally the "greatest" both in the size of the audiences and in the size of the orchestra, were held for five eventful evenings, August 11th, 13th, 14th, 15th and 16th, 1922, at—

At this point the reporter pauses. Ordinarily he would have written "at the City College Stadium in New York." But that would be only a fifteenth or a thirtieth of the truth—possibly only a hundredth of the truth. For while the great New York Philharmonic orchestra (considered by many the best in this country if not in the world) was playing at the Stadium, only an average of 7,000 persons were at that point at one time. Many times that number, just how many is a matter of conjecture, were scattered throughout this country, Canada, Cuba, possibly Mexico, and on ships more than half way across the Atlantic. For these concerts were broadcast from one of the most powerful and most popular broadcasting stations in the world, the famous WJZ, located at Newark, New Jersey.

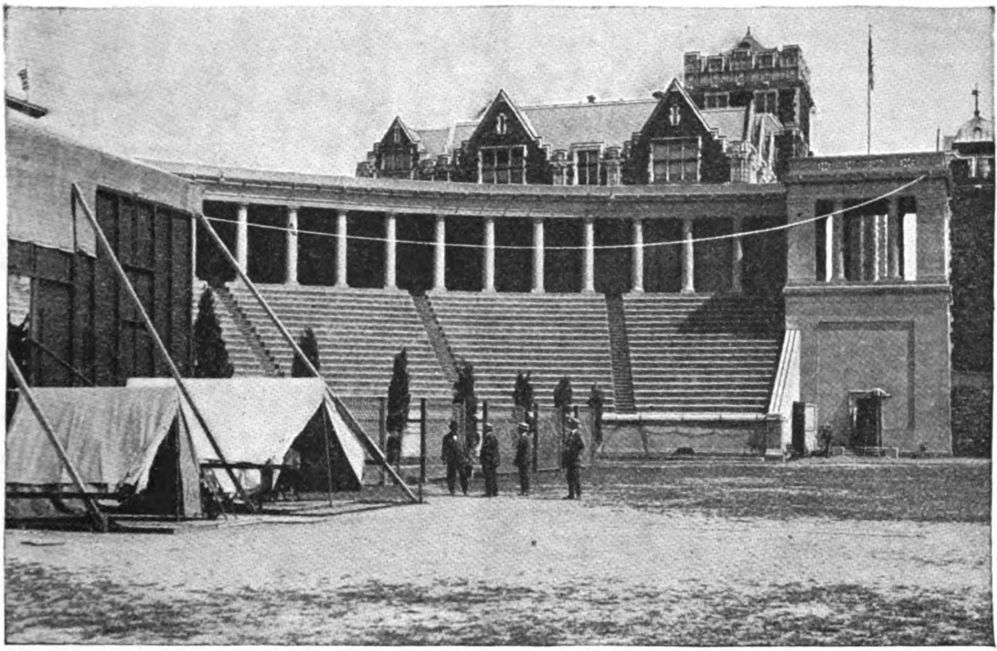
It is no small satisfaction that POPULAR RADIO feels in having initiated this enterprise and made possible a memorable and historical musical treat to the radio fans within an area conservatively estimated at 2,000,000 square miles.

The broadcasting of these concerts marks three notable achievements in the field of both music and radio:

First; it was the first time that the music of a great New York orchestra had ever been broadcast, or indeed the first time that any great symphony orchestra had ever been thus brought within the range of radio amateurs of any considerable part of the country;

Second; it was the first time that any outdoor symphony concert had ever been broadcast;

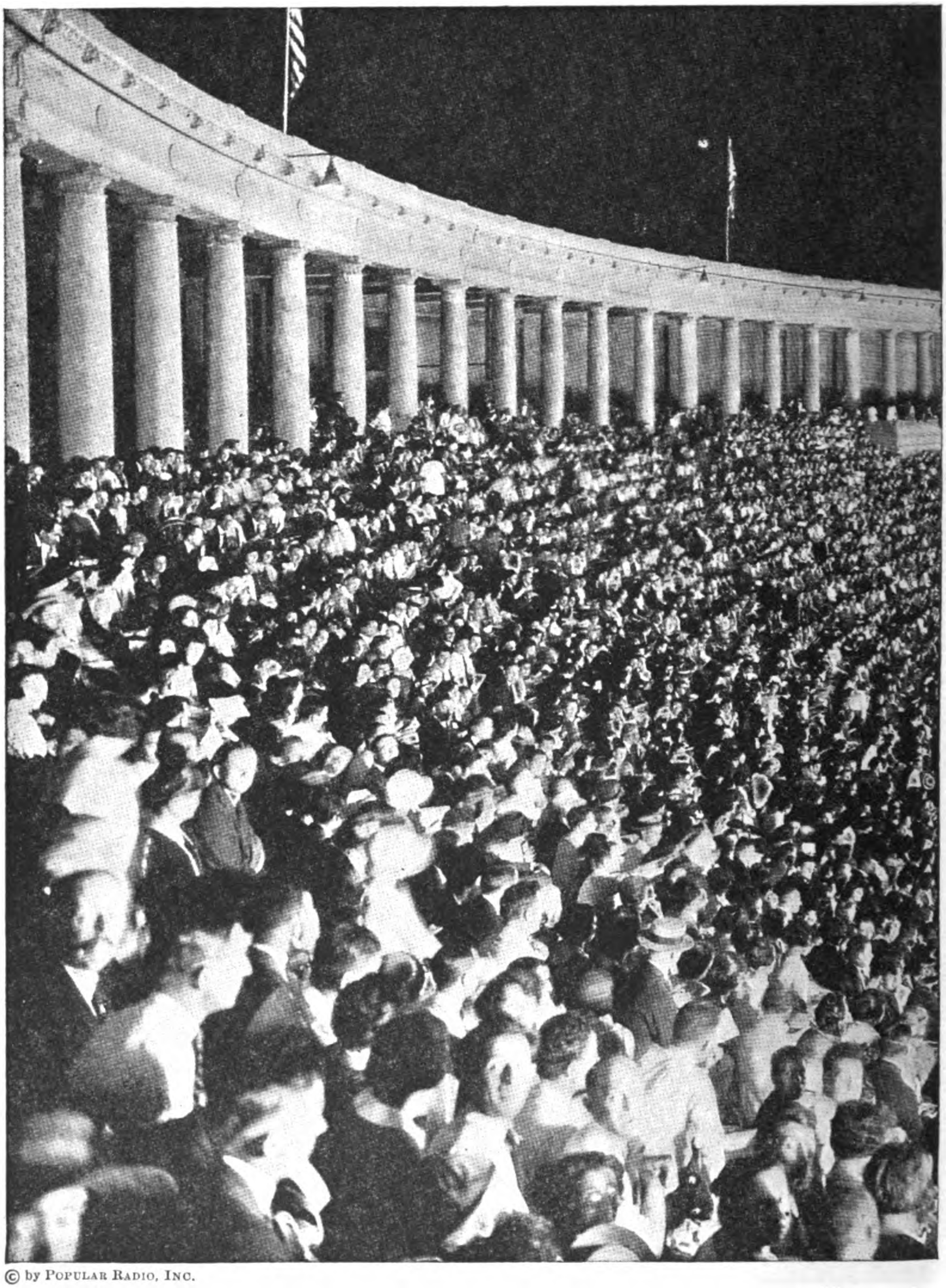
Third; it was the first time that symphony concerts had ever been transmitted by wire from the concert platform to a distant broadcasting station and sent out in its entirety through space.



From a photograph made for POPULAR RADIO

THE WIRE THAT CARRIED THE MUSIC

From the concert platform, the special telephone wire connected with the Audubon telephone exchange, whence it extended to the broadcasting station in Newark.



© by POPULAR RADIO, INC.

The GREATEST AUDIENCE EVER ASSEMBLED AT ONE CONCERT—
The night of August 16th, 1922, will go down as memorable in the history of both radio and of music. On that occasion about 15,000 persons crowded into the Stadium of the College of the City of New York to hear the New York Philharmonic orchestra play a Tchaikowski-Wagner-Liszt program.

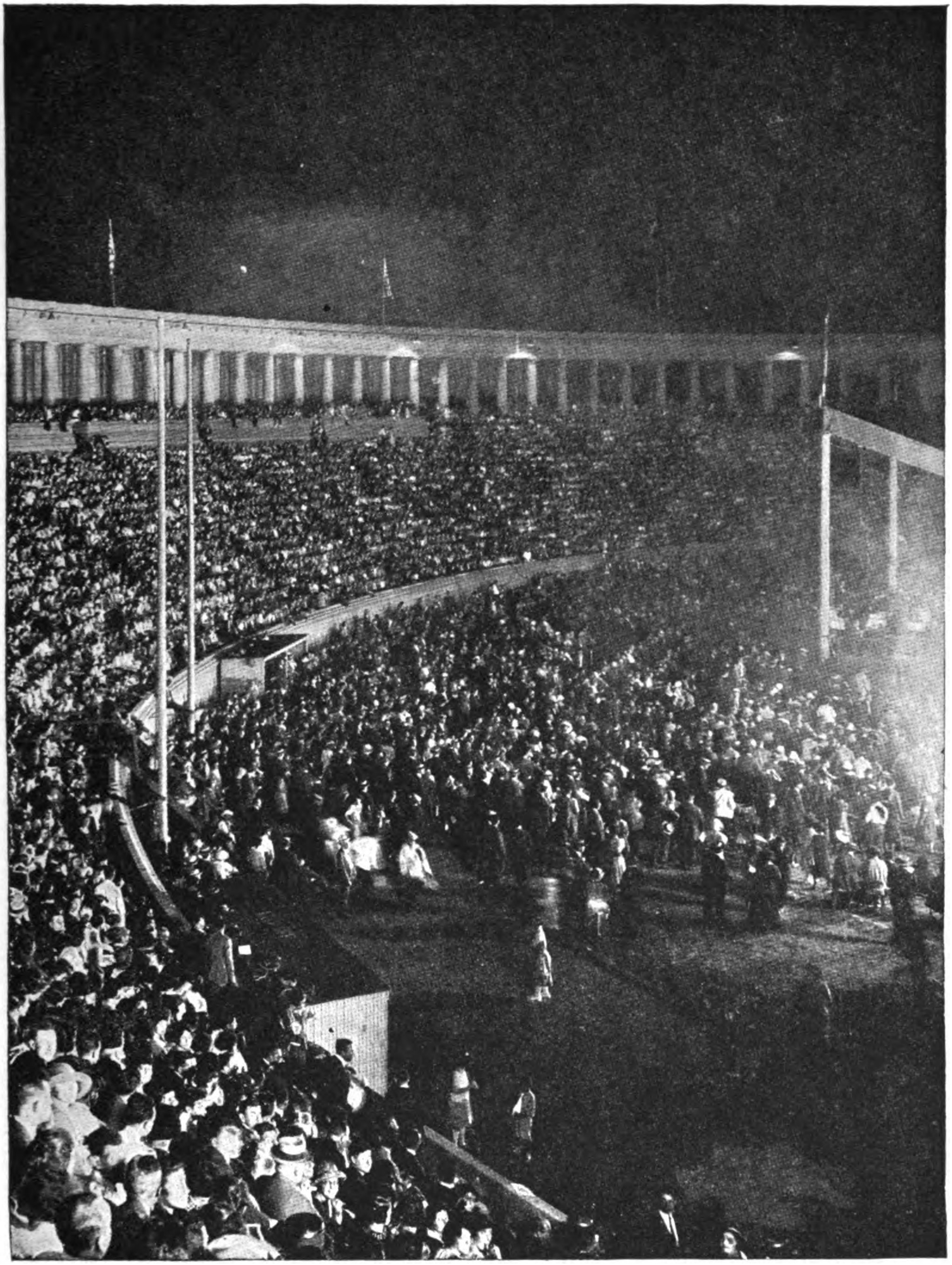


Photo by Drucker & Baltes Co., New York

—AND THE GREATEST CONCERT EVER BROADCAST BY RADIO

The music was transmitted by special wire from the concert platform by means of a microphone and sent out from WJZ to an audience estimated at 1,000,000—possibly a hundred times as many persons as appear in this remarkable flashlight, the largest outdoor flashlight ever made.

The plan for this unique undertaking was first proposed to the Stadium Concerts executives (Adolph Lewisohn, the donor of the Stadium in which the concerts were given, Arthur Judson, the manager of the series, and Cromwell Childe) by Kendall Banning, Editor of POPULAR RADIO. These gentlemen promptly seized upon the idea as a means of rendering a public service of a unique character. They realized that even if the Stadium was packed to the doors with standees, it could hold only a little more than 10,000 persons. Only ten thousand could hear at one time the noblest of symphony music, superbly played. But with the aid of radio the same program, with all its cadences, all its tones, all its beauties of musical imagery, might be listened to by tens and possibly hundreds of thousands, sent through space over an area that comprised practically all the country east of the Mississippi River, the eastern part of Canada, and that part of the Atlantic that is included within a radius of 1,500 miles. In other words, the Stadium audiences could be multiplied perhaps fifty-fold.

From a photograph made for POPULAR RADIO

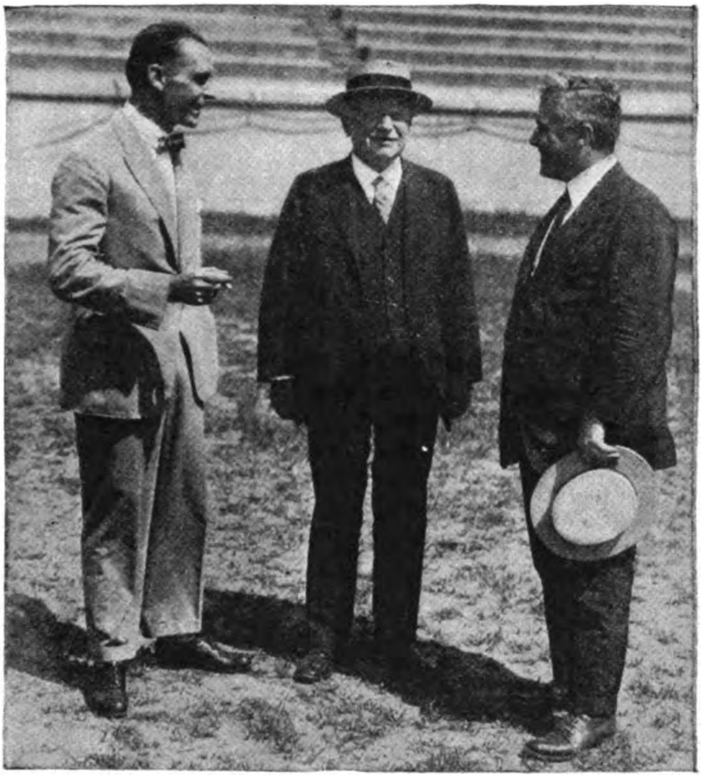
GETTING A LINE ON THE PHILHARMONIC ORCHESTRA

During the outdoor rehearsals on Thursday morning, August 10th, the telephone engineer completed the installation of the special telephone line. On the left is Dr. E. E. Free, and on the right Laurence M. Cockaday, both of the technical staff of POPULAR RADIO.

It was too good an opportunity to be disregarded. The Westinghouse Electric & Manufacturing Company, which operates station WJZ, was consulted; so were the executives of the American Telephone and Telegraph Company. Radio engineers of both companies were called in to study the many technical problems involved. The Westinghouse radio experts agreed with the technical staff of POPULAR RADIO that the experiment would be successful; the experts of the telephone company did not. Eventually, however, a special wire was put in and leased for the period of the concerts and the test was made—with results that are now a matter of radio history.

Radio equipment was installed that made possible the distribution of the Stadium concerts over a territory that represents a population of about 75,000,000 people, operating receiving sets roughly estimated at about 500,000.

The music of the New York Philharmonic orchestra was recorded by a special type of microphone developed by the Westinghouse Company. For the benefit of the uninitiated, it may be explained that this device, in appearance a small black cylinder, 4 inches long and 4 inches



From a photograph made for POPULAR RADIO

THE MEN BEHIND THE RADIO GUNS

At the left is William van Hoogstraten, who conducted the orchestra; in the center is Adolph Lewisohn, who not only gave the Stadium, but served as a patron of the concert series; at the right is Kendall Banning, editor of POPULAR RADIO, *who initiated the broadcasting project.*

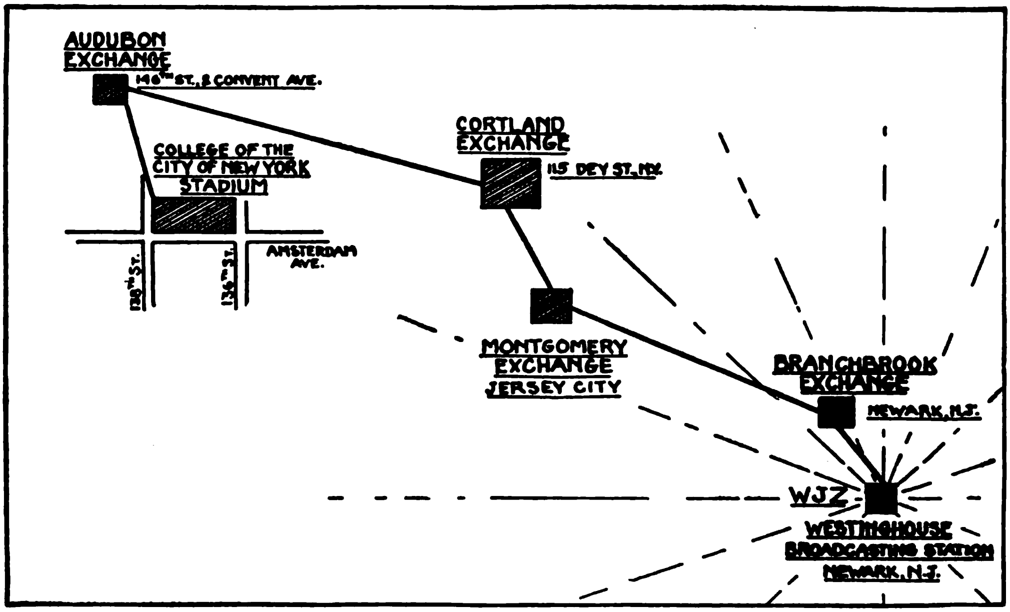
in diameter, was suspended in view of the audience about 25 feet in front of the platform and about 25 feet high. It was supplemented by a second microphone located just in front of the orchestra leader's platform for the purpose of recording the soloists. These microphones converted the music (as well as the applause that followed) into an electric current of strength and character that varied in accordance with the character of the sound waves that impinged upon the diaphragm.

This current was then transmitted over the special wire leased from the telephone company. The wire extended through the various telephone exchanges to the famous broadcasting station WJZ at Newark, New Jersey—a distance of 25 miles from the Stadium. At the broadcasting station the electric current was amplified by means of special vacuum tube circuits; the amplified current was then impressed upon the modulator tubes of the transmitting set. These modulator tubes in turn varied the output of the radio transmitter in accordance with the same sound waves that were impressed upon the microphones at the Stadium. The music thus broadcast could be picked up by any radio receiving set that tuned in to the prescribed wavelength of 360 meters.

How many persons listened in on these concerts will never be known. Some estimates have run over a million. Steamship companies on the seaboard and on the Great Lakes were notified in time to tune in at the prescribed hours and thus permit their passengers to participate in the event. Hotels did the same. The Astor Hotel in New York, to cite but one example, installed a receiver on its roof and dispensed with its own orchestra entirely on that occasion. Boy scout camps throughout the East tuned in on the advice of their general director, and amateurs generally recorded the experiment with something more than the usual interest, for it was a significant step in the history of broadcasting—and a step taken at a time when the future of broadcasting is still undetermined and fraught with uncertainties. It is perhaps worth more than passing notice that the first number on the first night's program to be heard in its entirety was, aptly enough, the gorgeous Symphonic Poem No. 2 of Saint-Saëns, "Phaeton"—the surname of the mythical sun god Helos, in which all radiant energy has its source.

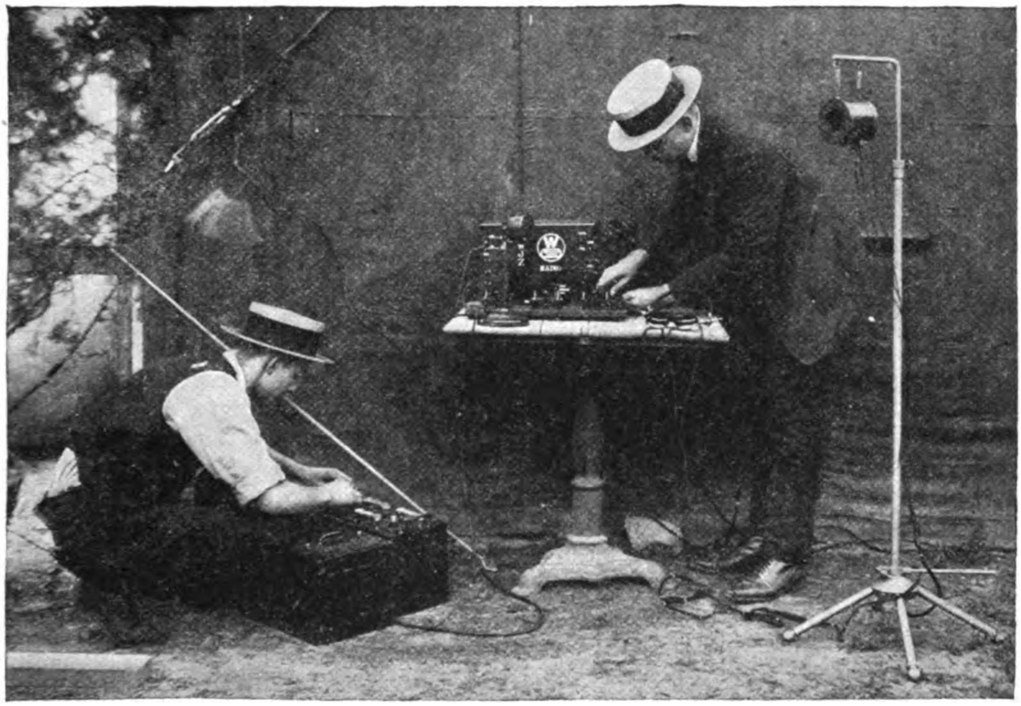
The significance of these concerts was not lost upon the press of the country.

"Cities which have no symphony orchestra of their own cannot hope for an opportunity to hear the greater organizations except at long intervals," observes the Philadelphia *Public Ledger* editorially. "This makes such a procedure as that of the New York Philharmonic the more welcome. Many wireless programs have been of the frivolous, frothy order, with the appetite of the devotees of jazz in mind. Here is an encouraging prospect of better things and an important aid toward an educated public appreciation of the best in music. When Sienkiewicz as a young man visited America he said he could find no music but that of the dance and a few lyric insipidities. There was nothing of Beethoven and the patriarchs—or even of the best of the moderns. How different would be the report if made today! Mechanical agencies of reproduction have vastly extended and intensified the personal effort of the artist. Never in musical history have artists, singly or in groups, had such a chance to be widely heard as they have today."



HOW THE CONCERTS REACHED WJZ

This diagram illustrates how the music was transmitted from the Stadium of the College of the City of New York to Newark—passing through four telephone exchanges (and under the Hudson River) on its historic journey across the State boundary line.



From a photograph made for POPULAR RADIO

INSTALLING THE MICROPHONE AND THE AMPLIFYING APPARATUS

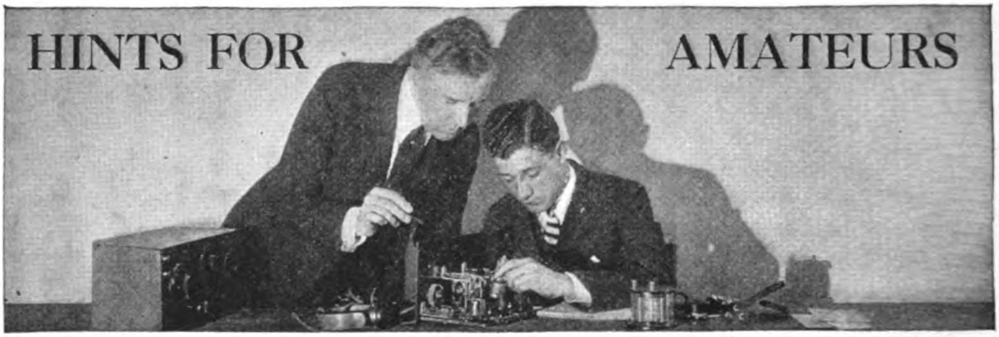
The microphone mounted on the adjustable stand (at the right) was used for recording the soloists; on such occasions the microphone suspended above the orchestra was not employed. The amplifiying apparatus was located on the platform during the concerts. It was in charge of Harry Hiller, who is here shown making the preliminary adjustments. The installation was made by William Frazier, the Westinghouse expert on modulation.

The New York *Evening Mail,* always a champion of good music, stated editorially:

"Last night was sent into the air a concert at the Stadium of the City of New York. Over a thousand miles of land and sea the Symphony program rendered by a great orchestra was flashed and perhaps a million people enjoyed its harmonies. They were the people who were prepared to receive it. The notes of the symphony were there for all within the radius of a thousand miles, but only those who had the proper equipment were conscious of them. . . . It may not be beyond the bounds of possibility that man is on the way to the development of the senses that will open up boundless fields of adventure and delight."

For the success of this undertaking the gratitude of the radio fans is due in generous measure to the efforts of Mr. Charles B. Popenoe, who has charge of the WJZ programs and who lent his prompt and enthusiastic help to the project from the first; to Mr. Walter S. Gifford, Vice-President of the American Telegraph and Telephone Company, through whose timely participation the necessary telephone equipment and service was obtained; to the management of the Stadium Concerts; to Dr. W. H. Easton; to the distinguished conductor, Willem van Hoogstraten, to the members of the Philharmonic orchestra, and to the soloists, whose interest in the enterprise did much to make it the notable success that it proved to be. They have the satisfaction of knowing that their concerts were probably heard by a larger audience than ever listened to a concert before in all the history of music.

HINTS FOR AMATEURS



To get the best results out of your detector tube you should use a variable "B" battery.

* * *

When your set fails to receive, first make sure that you have your antenna "on" and all connections correct and tight and your tubes lit up, before tearing down your set to find the trouble. Sometimes it is some minor fault, such as a loose connection.

* * *

Crystal detectors are easily knocked out of adjustment if some one bumps into the table upon which the radio apparatus rests; sometimes the vibrations of the building, caused by walking across the floor, shakes the apparatus. Many an amateur has been inconvenienced when the crystal has suddenly been thrown out of adjustment, by any one of these causes, in the middle of some interesting communication. This trouble may be reduced if not avoided by standing the receiving cabinet on a sheet of thick felt. The felt takes up the jars that affect the detector and knock it out of adjustment.

* * *

To get all the fun and enjoyment out of radio, one should by all means obtain a buzzer practice set and learn the code. If a person goes to a foreign country to live, he will not be satisfied to talk to people who speak only his own language, but will also want to be able to understand what other people are saying in the language of the foreign country. If he will devote a small time each day to learning the new language, he will soon be able to speak well enough to make himself understood and to understand what others are saying, so that he will make new friends and get a better understanding of what is going on around him.

Learning the radio code will do the same thing for you and let you "in" on radio as you never would be without this knowledge. Fifteen minutes a day with a friend who is sending to you will accomplish results that you would hardly believe possible. Buy a buzzer practice set; it consists of a buzzer, a telegraph key, and a battery.

* * *

It is better to have a separate rheostat for every tube in a receiving set, because you may desire to use different makes of tubes and with only one rheostat for two tubes or more, the tubes may not match up; some will burn too dimly and some too brightly. Even if the same kind of tubes are used throughout, the filament adjustment of all the tubes is not always uniform.

* * *

For winding coils to be used for short wavelength reception, ordinary solid copper wire covered with a suitable cotton or silk covering will be found to be just as efficient as the most expensive multistrand wire, such as Litzendracht wire. On the higher wavelengths the multistrand insulated wire will be found to possess a lower high-frequency resistance. This will be found to be true on wavelength about 3000 meters; but below this wavelength the solid wire may be used with results that compare favorably with the other wire.

* * *

A WAVEMETER is a device for measuring the wavelength of either a signal which is being transmitted from a station or which is being received at the station where it is in use. It consists essentially of an inductance or coil (or a number of coils for different wavelength ranges) across which is connected a variable condenser. When the variable condenser is rotated the capacity of the condenser changes, thus varying the frequency to which the circuit will respond. If we know the frequency to which the different settings of the condenser will correspond, we can easily find out the wavelength that corresponds to that frequency from a table of frequency and wavelength. Most wavemeters have a switch which permits the wavemeter to be used for determining the wavelength of either a transmitted or a received signal.

The use first mentioned is for tuning a transmitting set and the second use is for finding out the wavelength of another station which is sending at the time. A diagram of connections is shown in Figure 1.

* * *

WHEN tne switch is thrown for determining the wavelength of the transmitting apparatus in the station, the wavemeter is really, in effect, a small receiving set without any antenna circuit. A crystal detector is used and when the wavemeter is placed somewhere near the coils of the transmitter, the wavemeter may be tuned by rotating the variable condenser till the signal is heard loudest in the telephones. When this is done, the wavemeter has been tuned to the same wavelength as the transmitter and this wavelength may be read directly off the calibrated scale of the variable condenser, which is calibrated in meters. In this way the operator may be sure that he is sending out signals of a wavelength that it is lawful for him to use.

* * *

WHEN the switch of a wavemeter is thrown for determination of the wavelength of a distant transmitter whose signals are being received, a buzzer is connected into the circuit and the telephones and crystal detector are disconnected. The wavemeter in this state becomes a small transmitting set and the coil of the wavemeter is placed in inductive relation to the coils of the receiving set in the station. The receiver is then tuned in the usual manner to the wavelength of the incoming signal, and then the buzzer in the wavemeter is set into operation by pressing a button on the wavemeter. This starts the miniature transmitter in the wavemeter sending out a feeble wave. The variable condenser in the wavemeter is then rotated until the sound of the buz-

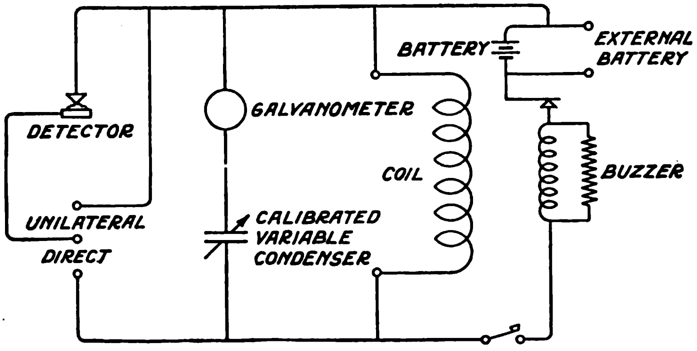


FIGURE 1

A diagram of connections of a wavemeter. When tuning a sending set, the telephones are connected to the two binding posts marked "unilateral"; for receiving, the two posts marked "direct" are used.

zer is heard loudest in the receiving set. When this is done the wavemeter, the receiving set, and the distant transmitting set are all tuned to the same wavelength, and this wavelength may be read off the scale of the wavemeter variable condenser. There is a pointer on the variable condenser which points out the correct reading as the condenser is rotated. A picture of a wavemeter is shown in Figure 2. Note the different-sized coils that may be inserted to get different wavelength ranges. The galvanometer is sometimes used instead of the crystal detector and telephones.

Now you can see how easy it is for the radio inspector to check up on your wavelength. Better watch out that your transmitting wavelength is within the lawful limits!

* * *

When the novice starts to tune a new regenerative receiver he usually gets all kinds of squeals, squawks and grunts—but no signals. It is only natural that he blames the receiver. Sometimes he goes back to the manufacturer and claims that he has been cheated; that the apparatus does not work, did not work and never will work. The set is then tried out by the manufacturer or dealer and found to be satisfactory. The trouble in nine cases out of ten lies with the purchaser; he either does not rig up the set correctly or does not understand how to operate it. Most of the howling noises are caused by turning the regeneration dial around so far that the detector vacuum tube produces oscillations that combine with the incoming signals and start to squeak.

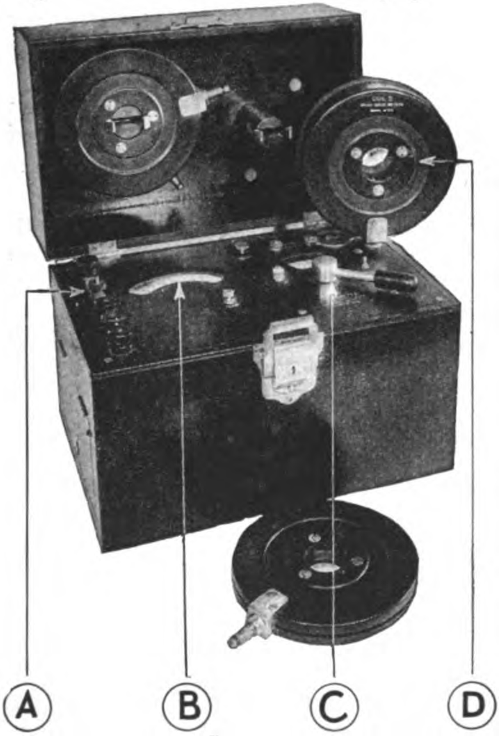


Figure 2

A wavemeter. A is the crystal detector, B the galvanometer, C the variable condenser and D the inductance coil.

Learn to operate your set before you pronounce it no good. Ask some friend who understands radio to operate the set, and have him show you how to tune it.

You would not think of purchasing an automobile and starting to drive it home if you did not know how to drive; you would not fool with the levers and switches on the car in the hope that you would pull one or push one that would start the car on the way homeward. Then do not expect to get results from your radio set until you understand at least what the different knobs are for, and have had a little practice tuning in the different wavelengths. "Practice makes perfect" in radio as in everything else.

* * *

You can make serviceable binding posts out of 8-32 round head machine screws, a nut to fit, a couple of washers, and a round thumb-nut off the top of a worn out dry battery.

* * *

"Howling" in an amplifier can sometimes be stopped or reduced by adjusting the filaments of the vacuum tubes. If this fails, try attaching a wire between the negative terminal of the "A" battery and the ground. Another idea that helps is to ground the iron cores of the amplifying transformers.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Who Says "There Are No Ether Waves"?

THE now famous article that appeared in our July issue, "There Are No Ether Waves," with which the distinguished physicist, Dr. Charles P. Steinmetz, stirred up the world of radio, has brought forth a flood of "replies" and inquiries from laymen and scientists alike. Space forbids the publication of more than a small fraction of these communications, but here is a short and pointed one from Louisiana that furnishes food for thought:

I have read with interest the article by Dr. Charles P. Steinmetz in which he calmly brushes aside the consensus of opinion of a dozen great scientists and substitutes for the hypothetical ether of space an even more hypothetical "storage of energy in space," which he does not analyze, explain or apparently admit the possibility of explaining. Men of science the world over will judge whether the great electrical engineer is a greater electrician than philosopher.

Herbert Spencer was the father of the theory of the relative nature of anything cognizable, and Spencer (who was the parent of modern psychology) proved that the brain, as the organ of the mind, had certain well-defined limitations that made impossible a knowledge of anything except the relative. The absolute is unknowable; as Jack London put it, "There is no God but the Unknowable, and Herbert Spencer is His prophet."

Theories and generalizations are dangerous. The circular motion of a fly-wheel is an absolute motion, certainly not a relative one. The onward motion of a projectile, on the other hand, is purely relative to other matter as far as we know. The theory evolved by Spencer and applied to physics by Einstein neither proves nor disproves the "hypothetical ether." The greatest relative motion of stars scarcely exceeds 1,000 miles a second. This fact proves to my mind the soundness of the ether hypothesis. Friction is a property of organized matter, not of a homogenous solid—a fact that Steinmetz ignores in the tenth paragraph of his article. For if matter itself is a mode of motion in the ether, as the mathematical relationship of atomic weights certainly indicates, then there could be no friction between a homogenous solid and a spherocentric vibration in it. (I refer to a spherocentric vibration as the ultimate unit of matter, since only spherocentric vibrations can attract each other in a homogenous medium.) This theory of gravitation is easily proven. Drop two pebbles in a pond of still water; the waves radiate from two oscillating centers. Close observation will show that the centers tend to approach each other.

All the other phenomena of matter depend upon attraction thus explained, upon the radiation of the spherocentric vibrational energy with the gradual decay of matter, and upon "beat" frequencies similar to those of radio but much more rapid. The rapid radiation of energy seemingly makes this theory untenable, but the interaction of a vast number of such spherocentric vibrating points in the ether would tend to inhibit such radiation. That is why gravitation is comparatively such a weak force.

Let's have more articles by the real heavyweights, and Steinmetz certainly is one of them.

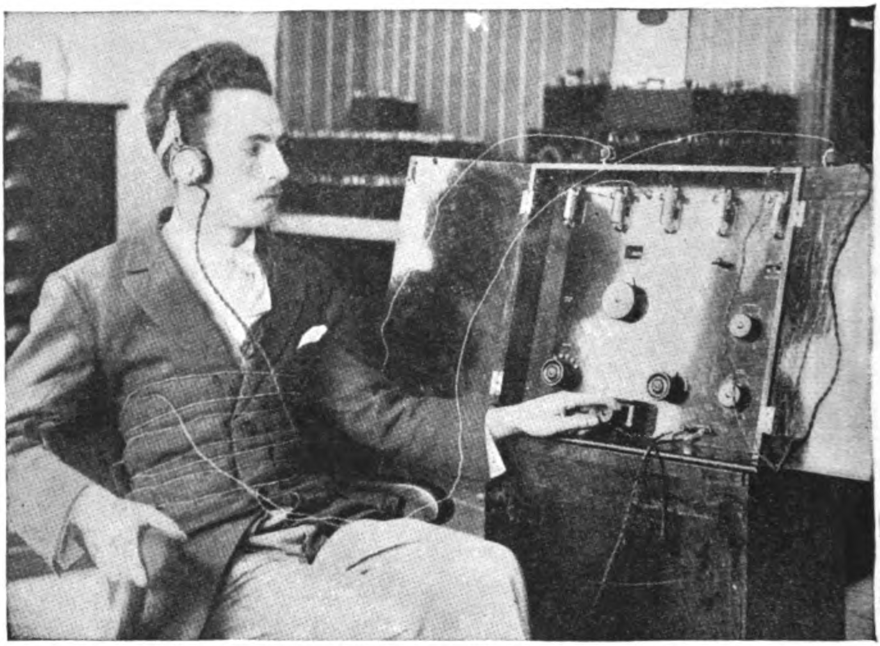
JACK ROGERS

* * *

How to Use a Regenerative Set as a Telephone Transmitter

TWO amateurs by accident find out that they can hold two-way communication between their houses by inserting microphones in their ground circuits. This is how they do it:

A friend of mine who is a radio bug lives a distance of about one block from my



Special Press, London

THE HUMAN BODY AS AN ANTENNA

If we were less conscientious we might start out to describe this picture in some such manner as this: "Acrials eliminated through the use of a wonderful new invention"—and then tell how to wrap a few antenna wires around one's body and receive radio signals from Europe. This would give a thrill to the layman and to the novice, and would probably cause a bit of talk at the dinner table. But it would not be the truth. The picture actually shows a man seated in front of a very sensitive receiver that uses radio frequency amplification (five vacuum tubes) with a wire, one end of which is fastened to the antenna terminal of the set, wrapped around his body. The other end of the wire is connected to the ground terminal of the set. The coil thus formed is in reality a horizontal loop antenna, and the set would function if the man were to wriggle out of the loop entirely. The body serves to add only slightly to the distributed capacity of the loop. With any set that employs three or more stages of radio frequency amplification the same results should be obtained. But the novice is warned that this is only an entertaining stunt and is nothing to get excited about.

house. One day I was listening in for amateurs, and I heard a weak voice saying:

"Hello, mother; can you hear me? All right, I'll sing a little song."

With that the voice proceeded to sing "Yankee Doodle." Now Bill has a voice that nobody could mistake and the more I listened the more I was sure it was my friend Bill with a new radio telephone transmitter.

I rushed over to his house and when he opened the door I shouted, "Where is it?"

"Where's what?" he said.

"The new transmitter," I answered. "I heard you."

Then he explained that he had taken an old telephone transmitter and "just for fun" he had connected it in series with the ground wire. Then with the set oscillating, he had spoken into it and was astonished to hear his voice repeated clearly in the telephones which he had on his ears at the time. He induced his mother to listen at the ear pieces while he talked to her. It was at this point that I had caught his voice over at my own house.

After the excitement was over Bill suggested that I get an old unused telephone transmitter and he would listen-in at his house for me, as we both had the same kind of single circuit receivers. I did so, and Bill reported that he heard me very well.

After a week of experimenting with other transmitters and using amplifier tubes and higher voltage "B" batteries we can talk back and forth with our receiving sets. Bill has done four blocks with his set.

ALBERT LANGLY

* * *

How to Restore Worn-Out Crystals

DO your crystals wear out quickly? Often this is because they are dirty. A reader tells how he brings back the sensitiveness of his crystals. He writes:

> I have found that I can bring back the full rectifying qualities of my worn-out and dirty crystals by immersing them in a bath of alcohol for fifteen minutes and then allowing them to dry. The hands should never touch the crystals, as a minute coating of dirt or grease is thus smeared on the surface and an imperfect contact is made by the little adjusting spring.
>
> A. K. Benton

* * *

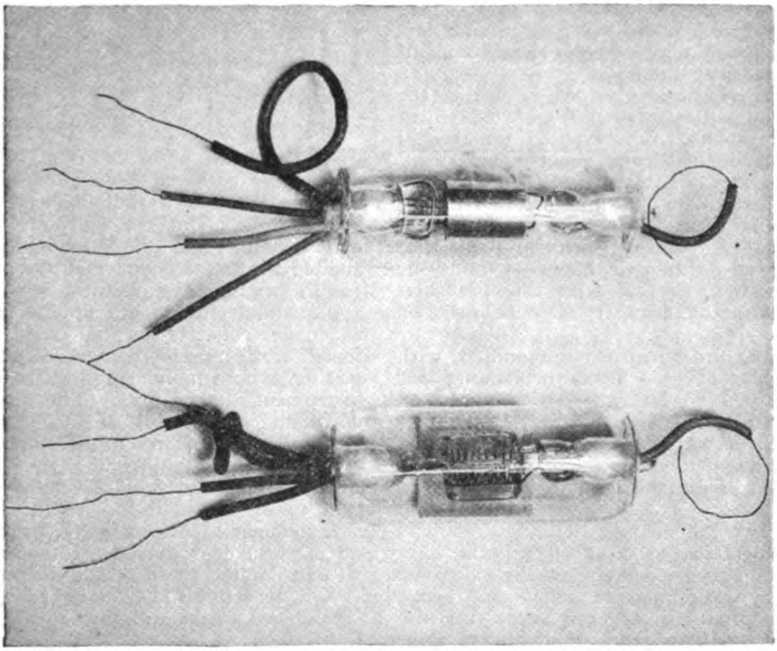
Vacuum Tubes *from* Japan

JAPAN, with her great fleet of merchant vessels as well as war vessels, is keeping abreast of the times with her radio equipment, and following her general policy in other lines, she is "making her own." Here is a letter from a radio operator who recently visited a factory in Tokyo:

On a recent trip through the Far East it was my misfortune to have my one remaining detector tube smashed by a pet ape that had become attached to the expedition as a sort of mascot. My attempts to obtain vacuum tubes had resulted in all sorts of glass-blown objects being submitted by the native merchants in their anxiety to make a few American dollars. An interpreter would listen to the detailed description of the triode and would give assurance that he knew exactly what was wanted and just where it could be obtained; and in a few hours an electric light bulb or a perfume atomizer or a Turkish water pipe—blown glass of every description—would be laid at our feet. At length we were informed by a Japanese radio operator at Yokohama that if we would journey to Toyko we could find what we wanted at the Anaka Wireless Works. So in desperation we started for Toyko.

When we arrived we transferred from the train into rikshas. Considerable trotting up one narrow alley and down the next brought us to the factory. After the necessary diplomatic ceremonies, the manager invited us to inspect the plant. Great was our surprise to see so much highly advanced radio apparatus in process. Complete receiving sets, transmitting sets, motor-generators, radio compasses—everything imaginable in the radio line was there, and most of it was being made by quaint little slant-eyed Japanese factory girls.

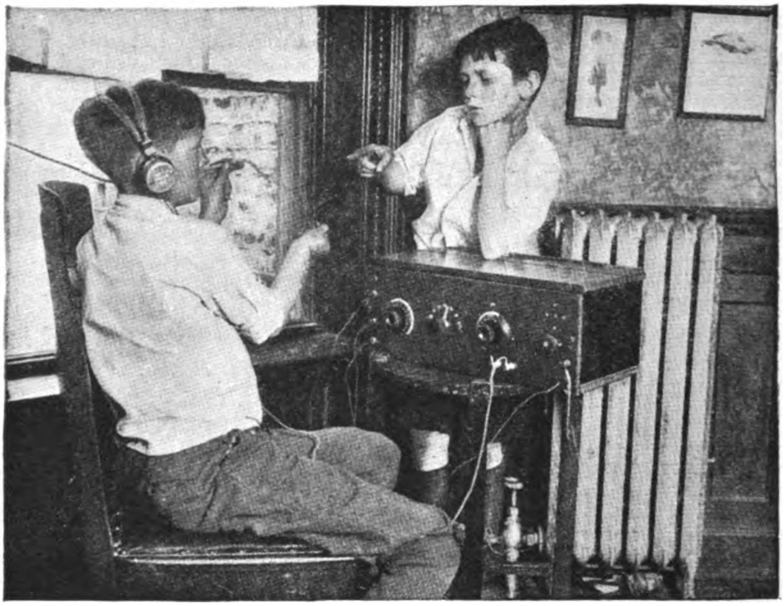
At length we were ushered into the vacuum tube department, where we found hundreds of the precious articles being turned out by the same pretty little girls. Their dainty hands deftly mounted the delicate filament wire, adjusted the grid and plate, formed the hot glass; as we watched them several tubes were completed. We marvelled at their



From a photograph made for Popular Radio

VACUUM TUBES WITH A JAPANESE ACCENT

The detector tube at the top is copied from an American model; the amplifier tube below it differs from our tubes in that it uses a second grid instead of a plate.



Kadel & Herbert

STRINGING THE LANDLORD

These young amateurs were forced by their lightning-scared landlord to take down their aerial on the roof. But they obtained a wire-core rope which they strung to the clothes-pole, thus combining the functions of clothes-line and antenna. The landlord has not discovered the subterfuge yet.

speed and accuracy, and were informed by our guide that these girls work on the plan we know as "piece work." We acquired a few of these tubes at a price equivalent to about $2.50 in American money.

Specimens of these tubes are shown in the accompanying illustration. We tried them with good results. One type is constructed with a square glass cage about the filament and grid. Upon this cage is wound a fine wire, about 18 turns; this is the plate. Another type has the conventional sheet metal plate curved about the other elements. Each tube is constructed with two filaments and one extra connection, so that when the first filament burns out the other filament may be used.

These tubes are furnished unmounted, with flexible rubber-covered leads protruding for connection. About 50 volts are required on the plate, and from 4 to 5 volts on the filament, which draws less than ½ ampere. This means that these tubes consume about half as much current from the storage battery as do American tubes. The detectors were found to be sensitive but critical, and the amplifiers not quite as efficient as the Yankee brands.

Radiophone transmission is being taken up seriously by the Japanese navy and army, who have produced several successful designs which are now being used on the ships as well as shore stations. But radiophone broadcasting in Japan has not as yet been started.

E. Jay Quinby

What Would You Have Done?

HERE'S a letter from Fall River, Massachusetts, that raises an interesting problem—which is solved in the present instance with commendable tact:

At the home of a radio amateur in town there were gathered a dozen people who had come to listen to a radio concert. They had been sitting about for an hour and a half, and one by one the broadcasting stations audible at that antenna end were signing off for the night. The operator was twirling the knobs and trying to put up the latter end of as many concerts as he could. Suddenly, there was music—strange distorted music, getting a note in here and there between the instrument's complaints. The operator tuned down and the strains of the "Star Spangled Banner" filled the room. Five people tittered and two laughed outright.

"Do we have to stand?" one of them asked.

"I think we ought to," ventured one.

A moment of discomfort followed, in which no one spoke or moved. Unwilling either to sit or to stand, these people did neither.

"Oh, let's not stand," laughed a listener.

"But we ought to"—the speaker half rose to his feet.

"We'll settle *that* question," said the operator. "We'll not listen to it." And he tuned it out!

Arthur G. Shirt

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask.* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department; it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: I have built the loose-coupled set as described in the July issue. I am not allowed to put up an aerial on top of the building. What other kind could I use? I am about four miles from the broadcasting station. Could this set be changed to a vacuum-tube set?

J. GIVEN

ANSWER: In this emergency you can run insulated wires in back of your picture moulding throughout your house and use it for an antenna. This should enable you to pick up the broadcasting at this short distance. There is no fire hazard in such an indoor antenna. In a near future issue of this magazine we will publish an article telling how to increase the range of the set described, by the addition of a vacuum-tube.

* * *

QUESTION: I have a Clapp-Eastham Type HR Radio receiving set and want to learn the dots and dashes so that I may read the code messages. What is the best way to learn this, and from what concern may I obtain the radio alphabet?

SIDNEY RAND

ANSWER: Consult the article by Paul McGinnis in the July issue, "How to Learn the Code." You may obtain a copy of the code by writing to the radio inspector of your district, or by sending to the office of the Secretary of Commerce for a copy.

* * *

QUESTION: While listening on my radio set, my brother upstairs happened to start tapping on his telegraph instruments that he has connected up on a board. While I could hear the outside sound only faintly, I could hear the ticks in the phones very distinctly. Can you explain this please? Also please give me a hook-up for an audion bulb connected to the set shown in the July issue.

H. STIBBARDS

ANSWER: The phenomenon you describe was caused by induction. The coil magnets in the telegraph sounder sent out feeble magnetic disturbances which were picked up by your set and made audible as clicks in your telephones. An article in a near issue of this magazine will show you how to increase the receiving range of the set described by the addition of a vacuum tube.

QUESTION: Which is the better tuning inductance, the spiderweb coils or the loose coupler?

MILTON DEWITT

ANSWER: Both types of tuners have their advantages and disadvantages, but you probably will get more satisfaction out of the spiderweb coils if used with variable condensers, as this affords an easy and efficient means for tuning.

* * *

QUESTION: I have an audion detector and short wave regenerative set hooked up and composed of standard parts. I have two detector tubes; when I listen I have to put up with a high-tensioned squeal. One tube is as bad as the other, yet when I take the tubes over to a friend's house they work with the best of results. My set works well except for the whistle. In my location I hear WJZ, KDKA, WGY, WGR, 8QB, NOF and many others. Could you tell me what I can do to stop that irritating squeak or whistle? Could it be my ground or aerial system?

S. L.

ANSWER: The trouble is not in your antenna or ground connection; it has entirely to do with your vacuum tube circuit. You are not explicit in describing the symptoms; there are many causes for whistling in a regenerative receiver. Sometimes it is caused by having the regeneration control turned around too far; this causes the tube to oscillate, and the combination of the received frequency and the generated frequency in the tube cause a "hetrodyne" action, thus producing the whistle. Another cause of whistling is the use of excessive filament current. Try turning down the tube rheostats a little. Still another cause is the use of a slightly excessive "B" battery potential on the plate of the tube. Try reducing this voltage a cell at a time and see if this doesn't remedy your trouble.

* * *

QUESTION: I have a small A. C. Thordarson toy transformer having a voltage ranging from 2 to 28 volts in steps of 2. Is it of any use in radio?

ANGEL F. BRUNO

ANSWER: This transformer is of no use in a receiving set, but it might be used in connection with a Tungar rectifying tube for charging your storage batteries. It could be used advantageously in a tube transmitting set for lighting the filaments of the tubes.

QUESTION: Please give me some details on how to construct a loop antenna for listening to broadcasting on 360 meters. What kind of wire shall I use? How much shall I use? Can it be placed on the second floor or the first floor of an ordinary dwelling, or must it be on the roof? How will the results compare with my one wire 100 feet long and 25 feet high outside?

C. L. SIGLER

ANSWER: A loop suitable for use on 360 meters may be made by winding 12 turns of No. 18 copper wire, covered with a single cotton covering, on cross-arms which can be mounted as shown in Figure 6. The length of the arms should be 3½ feet. The turns should be spaced one quarter of an inch. The two ends of the wire are attached to the receiver. The loop may be placed anywhere in the house, close to the receiver. Using two stages of radio frequency amplification you should get the same results as you would with the detector alone on your outdoor antenna. With two stages of radio frequency amplification and two stages of audio frequency amplification you should be able to hear the broadcasting all over the house using a loudspeaker. See Figure 1.

The loop antenna is directional in a line of its planes.

* * *

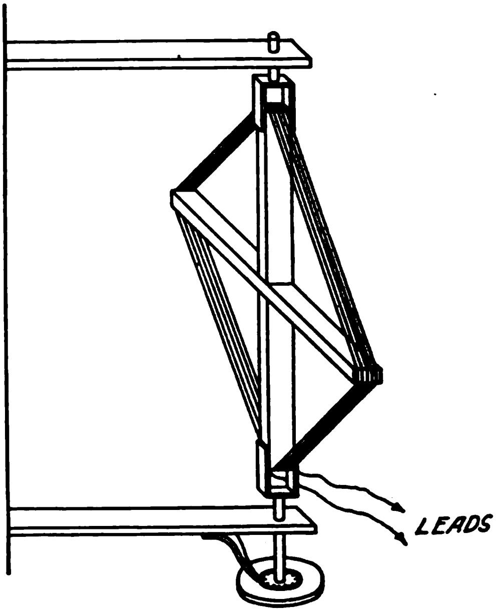


FIGURE 1
A loop connected to a receiving set that is equipped with suitable amplifiers is effective in tuning out directional interference.

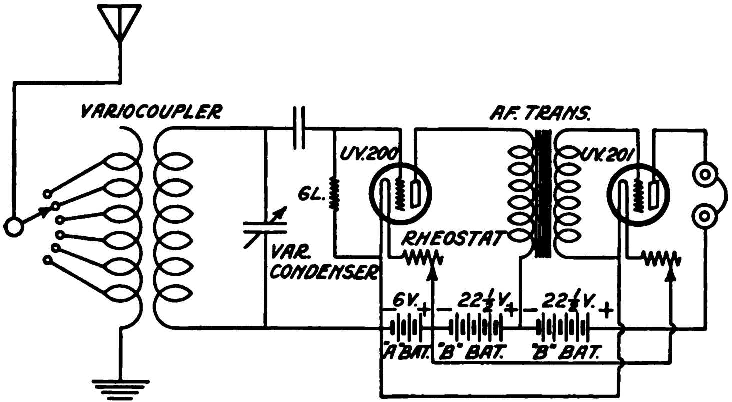


FIGURE 2: *A straight audion circuit with one stage of audio frequency amplification, employing a variocoupler and a variable condenser for tuning.*

QUESTION: I have the following radio parts. Could you give me a hook-up with which I could receive the broadcasting programs?

1 Variable condenser
1 Variocoupler
1 Grid condenser
1 Grid leak
2 22½ volt "B" batteries
1 6-volt storage battery
1 Pair telephones
1 UV-200 tube
1 UV-201 tube
1 Amplifying transformer
2 Tube sockets

LEE TUCKER

ANSWER: Figure 2 will show you how to connect your instruments. You will need two 5-ohm rheostats for controlling the filament current of the tubes.

* * *

QUESTION: I have a radio set which will receive a distance of forty miles, but the nearest broadcasting station is seventy-five miles away. Is there anything that I can do to receive over that distance?

TOM SHORT, JR.

ANSWER: You may add one or two steps of audio frequency amplification to your present receiver; and by doing so you will undoubtedly increase your receiving range up to, if not beyond, the distance that you mention. Such an amplifier was described on page 142 of the June issue of POPULAR RADIO, and diagrams and photographs of the apparatus will also be found on the same page.

* * *

QUESTION: I am going to get a government amateur license and am wondering what kind of a transmitter to install. I had two kinds picked out which were within my means; one was a spark set and the other was C.W. My aerial would be about fifty feet high and of the cage type; my spark transmitter would be a two-inch coil with an open gap and helix. My C.W. transmitter would use an amplifier vacuum tube with 112 volts on the plate. Of course I would use it for telegraphy only. Which one would you advise me to install, not figuring on cost or up-keep? Which one would send the farthest for telegraphy?

ASHLEY C. DIXON, JR.

ANSWER: We would advise you without reservation to install the C.W. transmitter, as it is the most modern and the most efficient. In the August issue of POPULAR RADIO, on page 294, is a hook-up of a one-tube transmitter which would be suitable for you to use. Of course you may use the UV-201 tube instead of the larger 5-watt tube recommended. In this case you would not use the motor-generator as shown but you could substitute 110 volts from a "B" battery or else use the 110 volts A.C. house lighting current for telegraphy. The C.W. set will send much farther than the spark coil.

Other advantages of the C.W. set include quiet operation—without the noisy spark displays; sharply-tuned emitted wave, with small interference, and compactness.

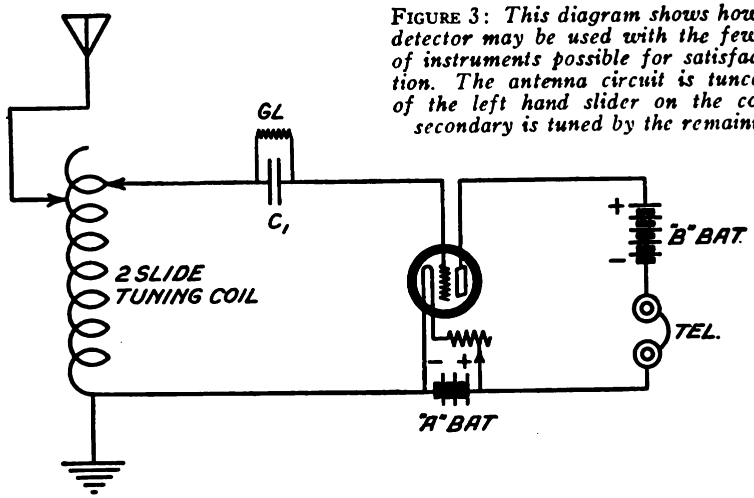


FIGURE 3: *This diagram shows how the audion detector may be used with the fewest number of instruments possible for satisfactory operation. The antenna circuit is tuned by means of the left hand slider on the coil, and the secondary is tuned by the remaining slider.*

QUESTION: How would a two-slide tuning coil be connected to the vacuum tube set described by A. Hyatt Verrill in the June issue of POPULAR RADIO? Please illustrate by a diagram.

BURNETT COOK

ANSWER: The tuning coil should be connected as shown in Figure 3. No variable condenser is necessary when this type of coil is used.

* * *

QUESTION: Will you kindly show me a hook-up of an installation of a lightning ground switch?

THOMAS HEDGES

ANSWER: The connections for the installation of the lightning switch are shown in Figure 4.

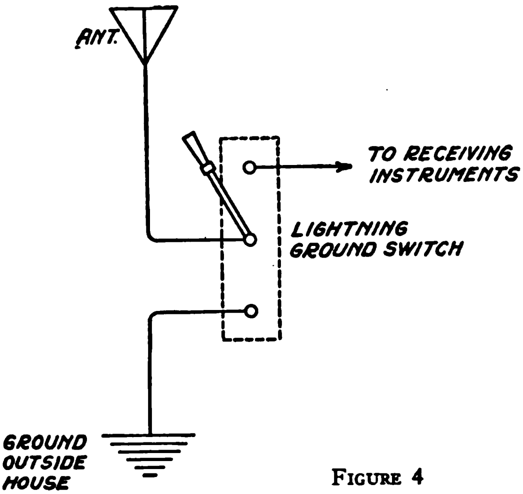


FIGURE 4

QUESTION: Please give a hook-up for a C.W. telegraph and telephone transmitter using one 5-watt tube and "B" batteries on the plate.

ORVIL WILSON

ANSWER: On page 294 of the August issue of POPULAR RADIO you will find a circuit for a 5-watt transmitter. You may substitute the "B" batteries for the motor-generator, in which case you may eliminate the filter circuit. This circuit is suitable for your needs.

* * *

QUESTION: Will it make any difference to my set if I join the ends of my aerial? Can you show me how to wind a honeycomb coil?

HAYWARD HEWSON

ANSWER: It will help in transmitting slightly if you make the proposed change. We would not advise you making your own honeycomb coils, as they can be bought at less expense than the time expended on making would be worth. The home-made coil would not be as efficient.

* * *

QUESTION: Has an antenna 35 feet high much advantage over one 25 feet high for receiving? Is it advisable to have antenna wire and lead-in wire in one piece?

ANONYMOUS

ANSWER: The effective height of the antenna would be increased, therefore the antenna would be more efficient. If the antenna wire and the lead-in wire are not one piece, they should be soldered. When soldered connection is made between the two pieces they will be as suitable as one continuous length.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from* 50 *to* 300 *words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East* 40*th Street, New York City.*

I Share the Thrill That Comes But Once in a Lifetime

OUT of the wilds of northern Canada comes this true story that carries with it something of the ring of triumph that we associate with tales of struggles of the heroes of old—only in this case the heroes are eminently modern and characteristically American:

It was the night of the trans-Atlantic tests, December 11th, 1921, to be exact, when (as all the world now knows) the members of the American Radio Relay League were trying to push their 200 meter signals over to England.

I was back in the heart of the bush in the northland of Canada on this particular evening. I had difficulty in keeping the shack warm, owing to a snuffling 30-below wind which found every unplugged crevice in the rough building. The day had been a hard one—most days usually are back here—and for an hour I had been listening to the "free for all" gang of amateurs. Some of their transmitters wheezed asthmatically, some trumpeted sonorously, and other C. W. signals came like the moaning of lost souls. After them came those amateurs who had qualified for special schedule tests by successfully transmitting over 1,000 miles overland in the preliminary tests.

It thrilled me to realize that I was listening to the cream of American amateurs, endeavoring with their pet equipment to fling the paltry energy of a few dry cells across the ocean wastes to throbbing England. Paul F. Godley was over there—somewhere—listening. As I slowly moved the variometers I would hear 3DH of Princeton studiously sending his cipher and call letters, followed by IARY, who would valiantly swing in, reminding me of soldiers snatching the swords from the hands of fallen comrades.

It was close to 1:00 A. M. and I still sat listening to the boys pleading across the dark Atlantic for a hearing—broken only by outside sounds of wolves howling faintly and the creak of moosehide thongs as my dogs outdoors grew anxious for battle. I had been looking forward to these tests for months and had the receiver tuned to a hair. Indeed I had twice mushed fourteen miles to the Post Office through a blizzard and bad drifts for a spare bulb which never arrived.

And now the time so much anticipated was here. Would we fail to get across to-night? We fell down last night. I will never forget the miserable pang, when, after a three hours' vigil checking up the strength of various stations' signals and speculating as to who would or should get across, I heard the monotone chant from MUU:

"No signals heard."

Was the task of getting through on 200 meters to Europe impossible? Some of the cleverest men in the radio world had said it was.

Thus the minutes slipped on, my mind first going over the fizzle we made of the last attempt during the early part of the year, wavering with doubt over last night's "No signals heard" from Godley, only to be eventually buoyed up by new hope which fed on dying hope.

During the tests I had removed the aerial and ground from the set, and still some of the boys pounded through to me—here in an Arctic world—on the edge of everything!

It was 1.59 A. M. I snapped in the honeycomb coils on the long wave set, threw the aerial switch over to the 300 foot single wire, and began sliding the condensers over for Paul's message from MUU at 2 A. M. On my way up I passed the Old Reliables, NDD the fiddler, NPM the hand-bell ringer, and WSO the blacksmith. I was busy juggling out WII and WGG (scratching a clean, quiet spot for MUU) when—I heard the sweetest music that ever passed across a vacuum tube. It came like a vesper to a tired soul at eventide, over the seas from Canarvon, Wales—over a hundred blazing cities and leagues of darkened unmapped forests—right into this little shack here, nestling in the curving snowbanks of a white wilderness, telling me that Godley had "heard amateur signals from America in Scotland!"

Did I hear aright? Had I fallen asleep and just dreamed this thing? With dropped jaw I heard WII repeat Godley's message to our headquarters at Hartford, Conn.

A surge of emotion swept over me as I removed the receivers and dropped my head on my arms.

It had been done.

An American amateur, crouched on Scotland's bleak coast in the chattering misery of an icy, slanting rain, had accomplished a feat which has placed puckers of new thought on the broad brows of those eminent scientists who had smiled behind their hands. The American amateurs had achieved the "impossible."

M. J. CAVENEY

I Help Save a Child's Life

NOT often does a radio operator get the coveted opportunity to render service as came to the New Orleans fan who sends in this adventure:

I was stationed on a lonely island as radio operator for a prominent radio company. The only other means of communication with the cities was an uncertain and slow mail service by boat twice weekly when the weather permitted. I was alone at the station and so had certain schedule hours for working during the day and night. During the summer a few visitors came to the island for the bathing, and they used the radio service more or less to keep in touch with home matters.

One day there came to the island a prominent man with his wife and their little girl. The child was taken violently ill during the night. The distracted parents were at a loss as to what to do until the father came to the station, waked me and asked to get in touch the family physician in a nearby city.

I started my engine, got the station I wanted and asked the operator to get the physician on the telephone and have him hold the wire. He inquired how the charges were to be handled and I told him to keep a record of everything sent and received, also the telephone charges if any, and that my party guaranteed everything. There was no delay in getting the physician on the wire. I gave him the name of the party and described the symptoms; the physician in turn asked questions which were repeated to me, and I relayed the answers back to him. He then prescribed treatment and asked that we call him again in a few hours to let him know if the patient was relieved.

In a short time the father was back at the station and asked me to get the connection again and advise the physician that the pains were gone and the child was sleeping quietly; this was done and the doctor advised an immediate return to the city. Before leaving the next day both father and mother came to the station and were profuse in their thanks for the radio service.

This was the first time I had seen radio used in such manner and it made a deep impression on me. Without the radio service it would have been impossible to get medical advice promptly. It is probable that the radio saved the little patient's life.

GEORGE F. PATRICK

I Unfathom a Strange Phenomenon in the Head Phone

ONCE upon a time some college students carefully attached the wings of one kind of bug upon the body of another insect and submitted the result to their professor for classification. "This," announced the old gentleman gravely, "is a humbug." Possibly the second operator mentioned below was a student in the same class:

I relieved Bert Lane, the second operator, at six o'clock in the evening as usual. I picked up the magazine I had discarded when relieved from my morning watch, arranged the phones comfortably and lit my pipe. I noticed that Bert cleared out rather promptly.

Shortly after, I noticed a peculiar hum in the phones, accompanied by a scratching sound foreign to anything I had ever heard before. This came on at intervals for the first fifteen minutes or so of my watch. I put the occurrence down as a new brand of induction from the chief's ancient dynamo and didn't think much about it. Suddenly I became conscious that it was audible in one phone only, yet Cape Race was pounding away with a fine quality of sending in both receivers.

What was the cause of this strange phenomenon?

I became suspicious. I removed the phones, unscrewed the ear cap of the defaulting one, slid off the diaphragm . . . and out crawled a common fly.

How did it get there? Maybe Lane could tell.

T. C. VAN ALSTYNE

¶ *Are you thinking of taking up radio as a livelihood? Do you want to become a radio operator? Or a radio engineer? Do you want to know how, where the positions are and how to fit yourself for them?* POPULAR RADIO *will shortly begin a series of articles by practical radio experts that will tell you the real facts.*

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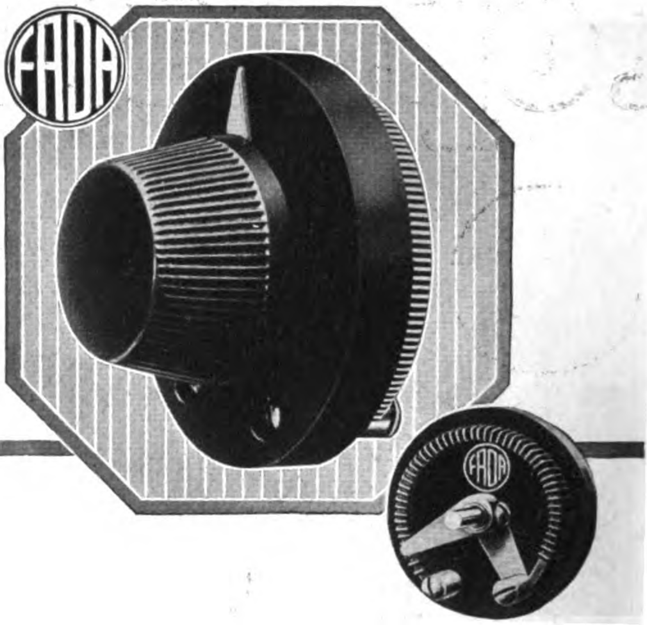

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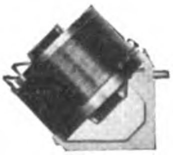

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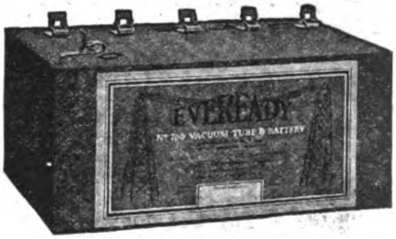

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POPULAR RADIO

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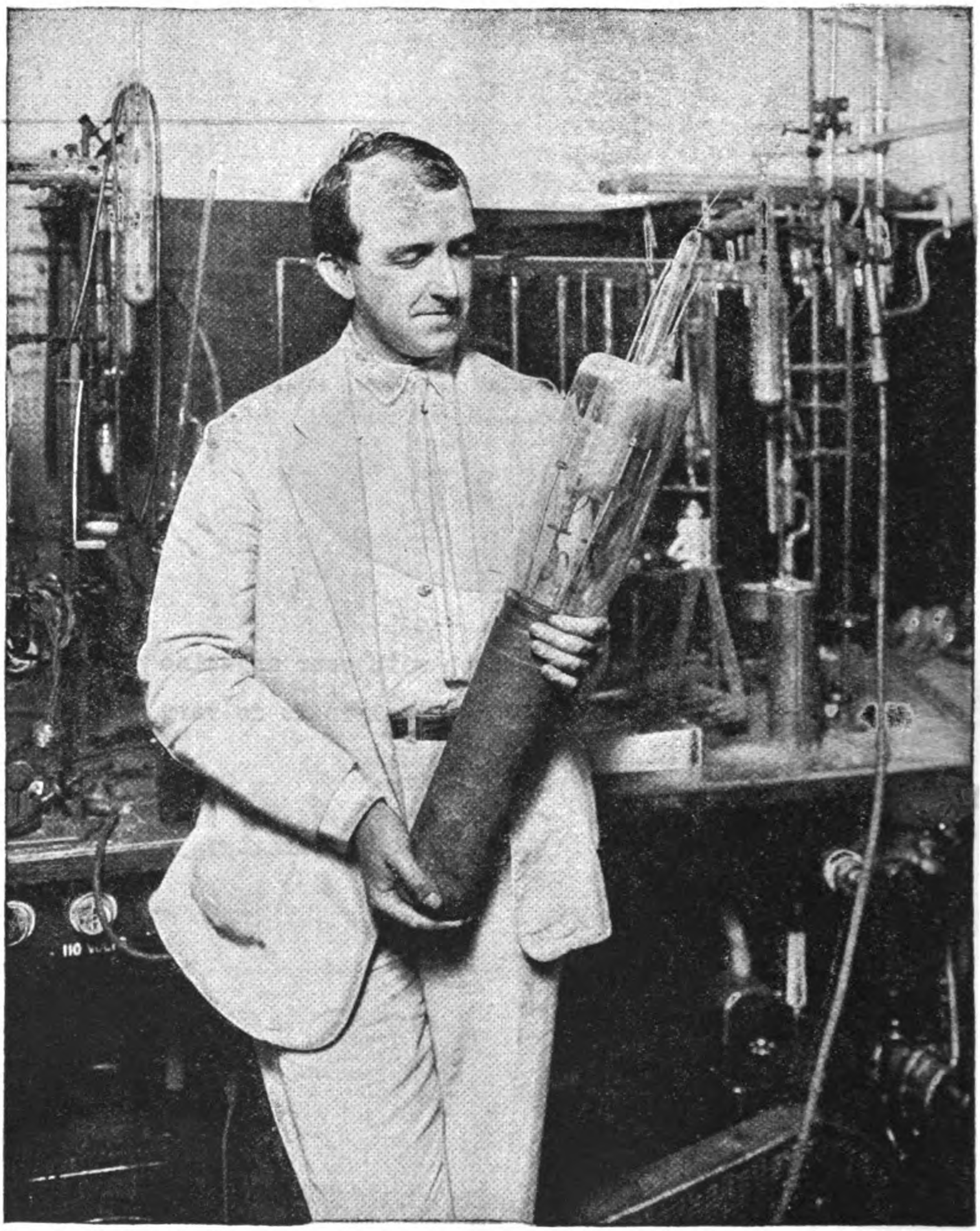
E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

I have been in touch with your magazine and consider that the material in it is very useful and valuable.

Elihu Thomson



Western Electric

The Most Powerful Vacuum Tube in the World

While it weighs only ten pounds, it is capable of supplying 100 kilowatts of oscillating high frequency energy to an antenna. Just what this means in the development of radio may be visualized by the fact that two of these tubes operated in parallel would do the work of about $1,000,000 worth of the machinery that is now used in trans-Atlantic communication. The inventor of this remarkable tube, W. G. Houskeeper, is shown holding his invention in the laboratory where he built it.

Popular Radio

VOLUME II NOVEMBER, 1922 NUMBER 3

Are There No Ether Waves?

An English Answer to an American Scientist

FOREWORD

IN the July issue of this magazine was published an article by Dr. Charles P. Steinmetz, the eminent American physicist, who denied the the existence of the hypothetical medium known as "ether," and contended that the ether hypothesis was not necessary in order to explain the phenomenon of radio. This contention aroused world-wide interest in scientific circles, especially in England, where the physicists generally support the theories of Sir Oliver Lodge, who is regarded as the foremost authority on the subject—and who frankly disagrees with the American. Dr. Steinmetz, in declaring against the ether hypothesis, claimed that "There Are No Ether Waves" and that the ether is not required for the propagation of "radio waves"—the existence of which he does not deny. The following article has, therefore, an international aspect that gives it an unusual interest in scientific circles.—EDITOR.

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE Theory of Relativity ignores the ether of space, "having no need of that hypothesis." It treats of occurrences mathematically, from the point of view of the individual observer, and in terms of what he can observe. It is quite clear that we, as human beings, can observe only matter. That is what our senses enable us to perceive, and everything else is an inference. Mind, for instance, makes no direct appeal to our senses, and though it is the instrument of consciousness it is a philosophic question how far mind can be regarded as an object of consciousness. But we are directly aware that we are thinking beings, and therefore each individual concludes that he himself possesses a mind, or if he thinks deeper he may conclude that he is a mind and possesses a body.

By some means or other most people come to the conclusion that they consist of both mind and body, though how rightly to express the conjunction may be difficult even to a metaphysician. We do not, however, directly perceive the minds of other people; we only perceive their bodies, but those bodies look something like our own; and the way they act suggests that they are similarly each associated with a mind. That, however, is an inference, and there is a system of philosophy in which it has been argued against—the system known as Solipsism.

To commonsense, however, such a

system seems absurd, and we most of us are quite willing to make the inference that other people have minds like our own, whether we directly perceive them or not. There are many other entities in like case — lots of things which make no appeal to the senses directly, but which are inferred from the behavior of matter.

Life, like the life of a tree for instance, is of such a nature. We only infer that a tree is animated by something which we call "life" because of the way in which it grows and develops and fructifies and reproduces and decays. But many biologists have doubted the existence of any separate vital principle, and endeavor to treat the organism as sufficiently explained by the laws of physics and chemistry and by the interactions of molecules, the effects of which they observe.

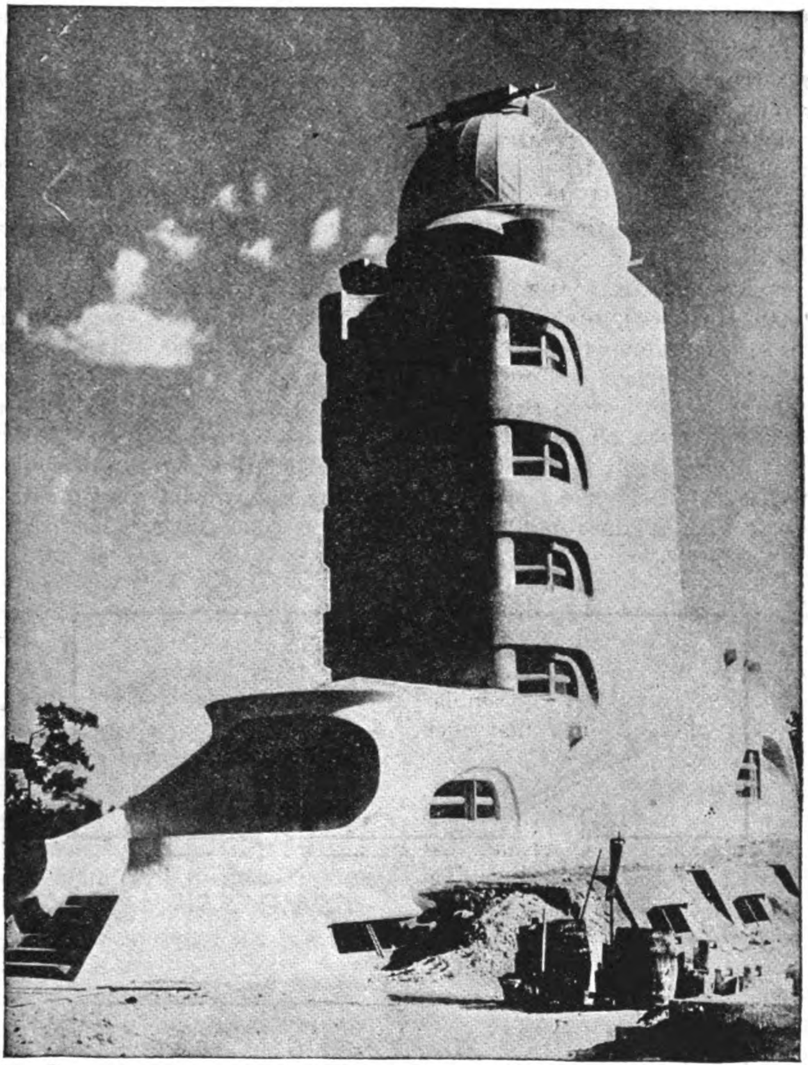
We might go further and say that electricity and magnetism are in a similar position. How do we know that such a thing as magnetism exists?

Only by observing the behavior of some kinds of matter—behavior which seems inexplicable unless we assume that it is, as it were, animated by something that we call magnetism, though we have no idea at present what it really is. It is hardly true to say that we have *no* idea; some of us have ideas, but there is no certainty about them. And I suppose it would be possible to work out a theory of the motions of matter without mentioning the term "magnetism" at all; for after all, by derivation, it only means the singular property of a certain stone which was found in Asia Minor. (The "lodestone," which pointed in a certain direction when suspended, and which imparted its property to steel, was supposed to have been first found near a place called Magnesia.)

But a gyroscopic compass points to the North, and the theory of its behavior can be worked out without reference to anything magnetic. Indeed there is nothing magnetic about it, it is only an elaborate spinning top. If we knew all about a compass needle it is probable that its theory could be worked out on somewhat similar lines. There is a hypothetical spin inside the atoms of the steel which may account for its behavior, just as the spin of the gyroscope accounts for its behavior, provided the spin of the earth is taken into account too. So it may be with magnetism. But no one has ever seen the magnetic spin, nor do we know for certain what it is that is spinning.

Again, we never actually see an electric current. What we observe is the motion of a compass needle which it deflects (as in a galvanometer), or the bubbles which arise in a liquid which it has decomposed (as in an electrolytic cell), or the light which is emitted by a filament which it has heated (as in an ordinary glow-lamp). No one has seen an electric charge. All we perceive is the behavior of bodies—the attraction of light things in its neighborhood; and to say that that behavior is due to an electric field, or that the pattern of iron filings is due to a magnetic field, is no better than saying that it is due to electricity or to magnetism. It might be difficult, but it would be possible, to work out a theory of the motions of matter without introducing those terms. And if we forcibly limited ourselves to that which was really and directly observed, such a theory would be the inevitable result.

That is what the Theory of Relativity aims at—to specify exactly what is perceived, and to make no hypotheses beyond it. If an observer fails to detect any difference in the velocity of light through space—whether he has reason to think he is moving toward the source or not—then let us proceed on the assumption that the velocity of light is absolutely the same relatively to every observer—granting the hypothesis, which is doubtful—for it *is* constant so far as the observer is concerned. If an observer is unable to detect any difference between his own motion and the motion of matter near



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THE BIRTHPLACE OF THE THEORY OF RELATIVITY

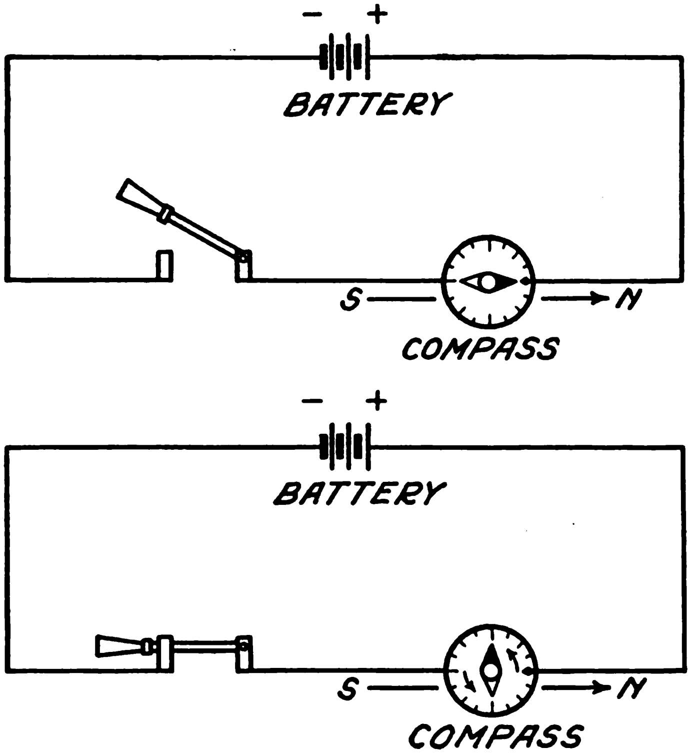
In this remarkable observatory, built near Potsdam, Germany, Dr. Albert Einstein evolved his famous theory which "dispenses with hypotheses and attends only to what can be observed and measured." Sir Oliver Lodge contends that these abstract factors must be reckoned with, whether or not we find that they can be "observed and measured."

him, then let us assume that there is no difference, and that everything is as relative as it appears to be. So says the doctrine of relativity. In that way we get rid of the idea of absolute motion, that is of the motion of bodies referred to something which is not matter—something omnipresent and fundamental, in which matter, ever since Newton, has been hypothetically held to exist.

The Theory of Relativity is professedly a pragmatical and observational mathematical theory: hence it is claimed that it ought to be acceptable to physicists. It dispenses with speculation, dispenses with hypotheses and attends only to what can be observed and measured. At least that is its ideal, though whether it quite comes up to its ideal may be doubted. We will give it the benefit of the doubt and assume that a theory of the universe can be elaborated without reference to anything but matter and its motion relative to other matter.

An interesting example of this kind of relativity is furnished by a letter in "Nature" for July 8th, 1922. A correspondent there points out that, of the two theories of the atom, one (namely Bohr's) requires the electrons to be revolving round a nucleus, while the other (Langmuir's) requires them to be stationary. He proposes a Copernican reconciliation, letting them be stationary while the nucleus spins on its axis, saying that according to the Theory of Relativity that should do just as well; in other words, that it does not matter whether a group of electrons revolve round a nucleus, or whether the nucleus rotates inside a group of electrons. Just so, according to an extreme relativist, it might be held that it makes no difference whether the whole system of stars revolves round the earth once a day, or whether the earth rotates diurnally on its axis.

Put in this way the notion is repugnant to commonsense and, we need not hesitate to say, is false. So also the reconciliation of atomic theories suggested in the ingenious letter to "Nature" is imaginary and devoid of efficacy. But according to strict relativity it is not so easy to say why commonsense comes to these conclusions. The fact is that



A DELICATE PROBLEM; HOW WOULD YOU DECIDE IT?

Sir Oliver points out that "Nobody ever saw electricity." But he also observes that "We do observe the motion of a compass needle which electricity deflects." For example, the upper diagram illustrates what happens when a compass is brought near a wire that has no current flowing through it; the lower diagram shows the change that takes place in the compass when a current IS flowing through the wire. Should we deny the existence of magnetism (or of the ether, for that matter) merely because our senses cannot yet perceive the agencies that produce the phenomena? Sir Oliver Lodge answers "No."

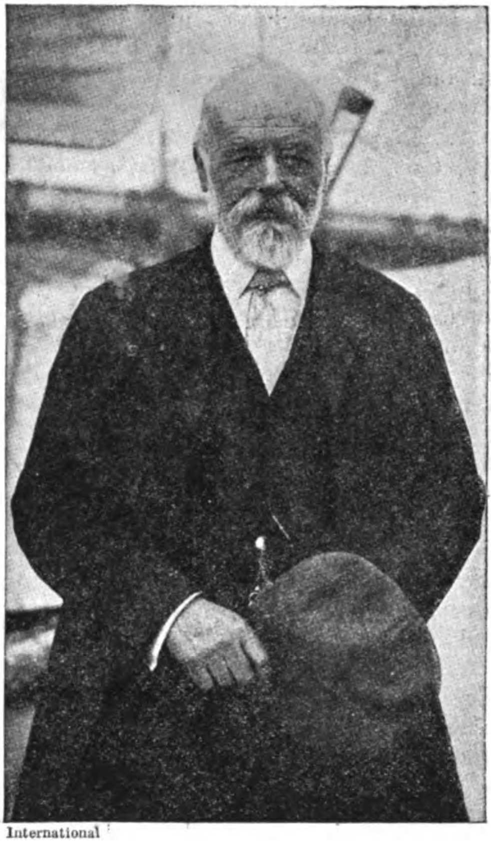
the centrifugal acceleration required for radiation cannot be conferred on an electron by a relatively rotating nucleus. Nor is it possible for the stars to move far quicker than the velocity of light—as they would have to if they were to revolve round the earth.

For what, after all, is the velocity of light, and why should a thing be unable to move faster than that?

If we wholly and finally ignore the ether, no explanation is forthcoming. We can only merely say that it is so. Relativists all agree that it is so—the equations demonstrate that—but by pure relativity they cannot explain why.

Hence those who have gone most deeply into the Theory of Relativity sooner or later perceive that there must be something substantial filling otherwise empty space; in other words that the ether is really and truly indispensable, however much for practical purposes it may be ignored. For though we can proceed a long way without mentioning or thinking of it, sooner or later it is bound to make its existence felt, not physically, but mentally, because of certain physical effects or consequences which are inexplicable without it, and because its existence is necessary to clear and adequate conceptions. To put it in the most ordinary and elementary form, one cannot really think of waves without some substantial medium for their conveyance.

Let it be known then that the great apostles of relativity have never denied the existence of ether. They have dispensed with mentioning it as far as they can. It does not seem essential to their theory as far as that has been worked out. It does not seem amenable to direct experiment; and they can write down their equations without attending to it. But to deny the existence of the ether, or of electricity, or of magnetism or life or mind, merely because we find it possible for many purposes to ignore them, is to stultify ourselves. And to accuse any of the great relativists of denying the existence of an ether is to attribute to a man of genius a stupidity which he is very far from exhibiting—still less of possessing.


International

TO DENY THE EXISTENCE OF FORCES WE CANNOT PERCEIVE IS "STUPID"

So states Sir Oliver Lodge in his spirited defense of the ether hypothesis. "One cannot really think of (radio) waves without some substantial medium for their conveyance," he argues. Sir Oliver was president of the Physical Society of London, 1899-1900; President of the British Association, 1913-14, and the recipient of the Rumford Medal of the Royal Society and of the Albert Medal "as a pioneer in wireless telegraphy." Among his twenty volumes on scientific subjects is "The Ether of Space."

How then is it possible for Dr. Charles P. Steinmetz to lay down the law and to say that "there is no ether," that "there are no ether waves," and that "according to the Theory of Relativity there can be no such thing"; and that no carrier for light or electro-magnetic waves is needed?

Plainly because he has gone a certain distance into the Theory of Relativity, and has not emerged into the atmosphere beyond it. He is satisfied with the way in which it works out the motions of matter as observed by the senses, and he considers that any inferences beyond the immediate testimony of the senses are illegitimate.

That, then, is where we part company. To limit ourselves to sense indications alone is to reduce ourselves to the level of animals. No one really does it; and some even of the animals may make inferences of a kind. Certainly it is our human privilege to discover, to infer, to generalize and to predict. And I advise those who are every day using the ether, for electrical and magnetic and optical purposes, not to confuse themselves with the gratuitous and rather stupid hypothesis that matter is all that exists because matter is all they perceive; but to allow their minds freer play, and to realize that many other things exist too, for which we have no sense organ.

So, if they care for my advice, I will recommend them to use a nomenclature in accordance with commonsense; to give a name to the substance or medium in which all their phenomena are occurring; to realize that wherever there is an electric field or a magnetic field or a gravitational field or a beam of light, there must be something going on in this medium—something which physicists can hope to analyze and examine and reduce to law and order. I would urge them not to remain satisfied with an abstract statement about the existence of unexplained forces in an absolutely empty, unphysical and merely geometrical space.

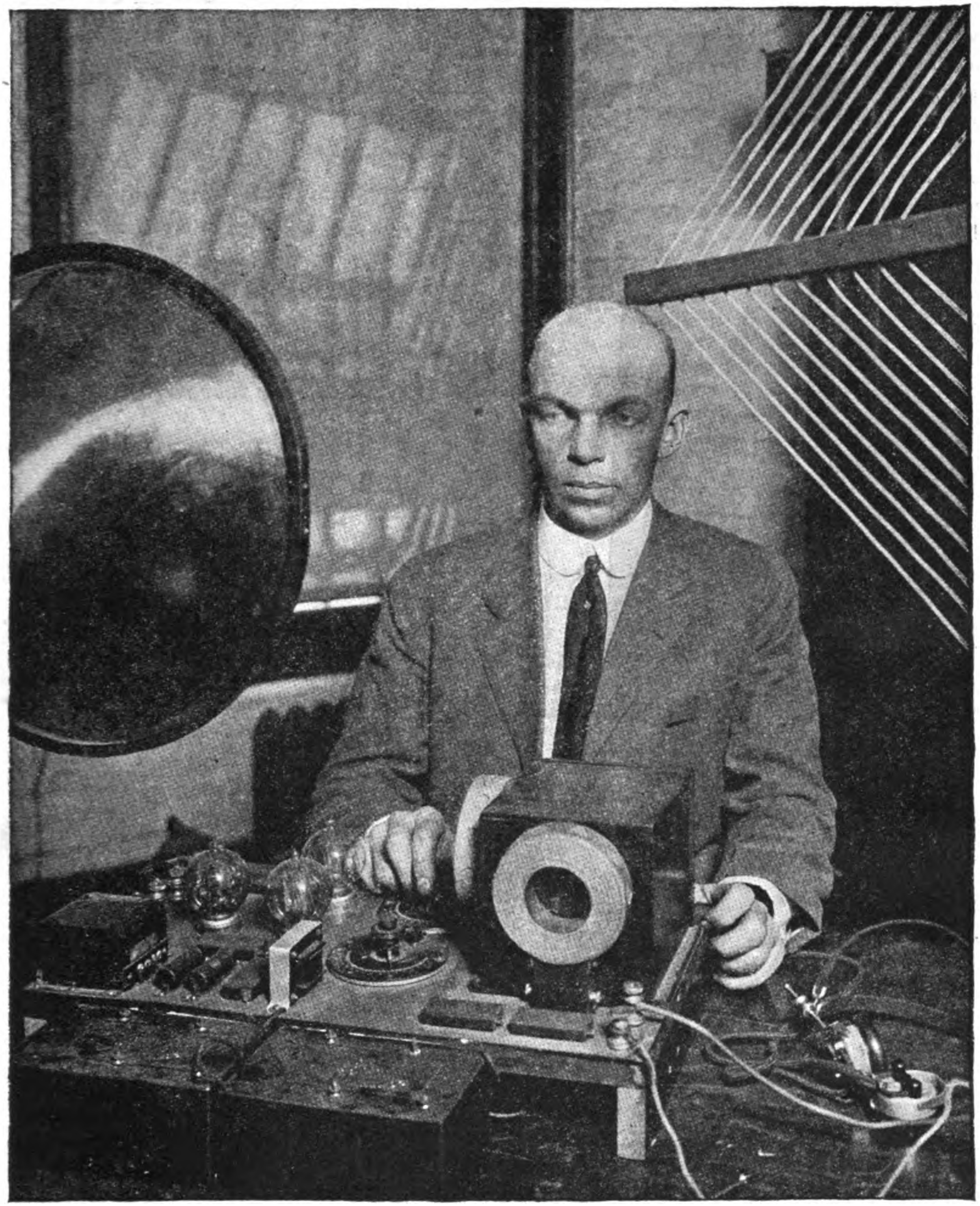
A field of force in vacua has to be accounted for: the mere statement that it exists is no theory. A theory of the ether has not yet been worked out, it remains for the next generation of workers to do it. Perhaps some of those now living will lend a hand. It is no easy task. Meanwhile we can remember always that the properties of the ether are largely unknown and remain to be discovered: which surely is a stimulus to us to pursue our researches. That which we know definitely about it, so far, is the rate at which it can transmit waves, and we know also a great many things which follow directly therefrom. We know further that it has properties akin to elasticity and inertia, which are experienced respectively in electricity and magnetism. Again we know (through the genius of Clerk Maxwell) that the combination of these two properties gives rise to that special kind of disturbance which stimulates the eye, and is responsible for all that is experimented on in wireless telegraphy.

Is There Really a "Heaviside Layer"?

"No," answers Dr. Elihu Thomson, one of the foremost authorities in the world, in his article in the December number of this magazine.

"Yes," answers Sir Oliver Lodge, with no less authority—in the January number that follows.

That two such eminent scientists should select POPULAR RADIO as the field for this international discussion is a matter of moment to radio amateurs throughout the country.



From a photograph made for POPULAR RADIO

THE MAN WHO ORIGINATED THE ARMSTRONG CIRCUIT

Hertz, Marconi, De Forest—and now Edwin H. Armstrong head the list of scientists who have made radio, as we know it today, possible. Armstrong has the unique honor of making three definite contributions to radio. FIRST, *he originated the regenerative feedback vacuum tube circuit.* SECOND, *he invented the super-heterodyne receiver—the most sensitive receiver ever produced.* THIRD, *he invented the super-regenerative receiver, which has just taken the world by storm, and which bears his name. Detailed instructions for building this super-regenerative receiver were published in* POPULAR RADIO *for September.*

My Orchestra of AUDIONS

Every radio fan who has heard the audio frequency "howling" of a home-made receiver will recognize the raw material from which the notes of this remarkable instrument are built and how wonderful musical tones are created by varying the inductance or the capacity of the vacuum tube circuit.

By
LEE DE FOREST, Ph.D.

Photo by Paul Thompson

THE undeveloped talents of the audion tube are undoubtedly numerous. One might let his imagination roam at will among its possibilities and never touch upon more than a small fraction of the applications some day to be discovered; many of them, doubtless, by the thousands of radio amateurs who are now free to pursue this still adventurous search.

There is one phase of audion application in which I have always had a deep personal interest. This application does not lie in the field of practical utility, but in the world of art and imagination, in the province of music.

For, in addition to its many other magic feats, the audion may be used to produce musical harmonies far more beautiful than those of any musical instrument yet devised.

Music from the audion! That is the theme which I suggest to those who are interested in the undeveloped possibilities of the vacuum tube.

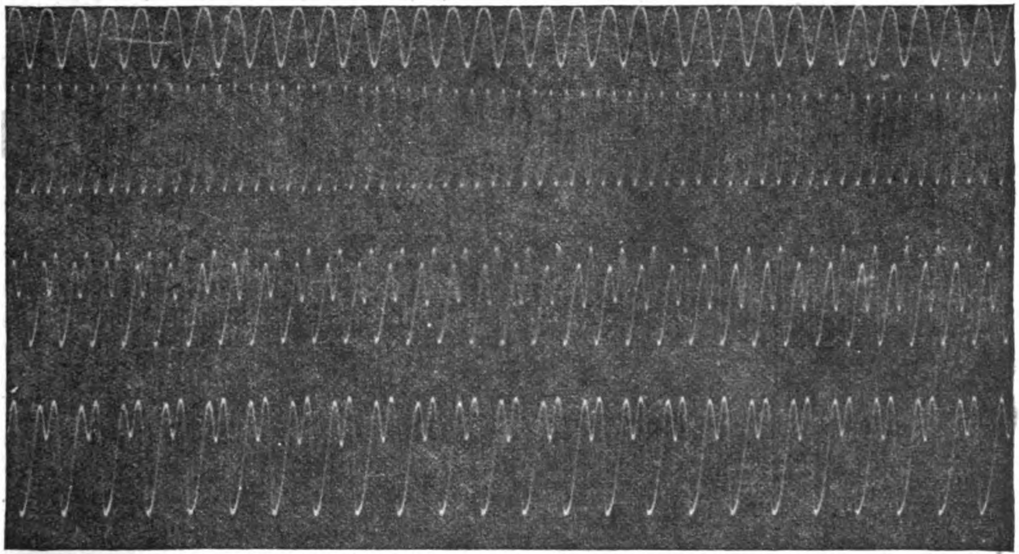
The audion serves not only as a detector, an amplifier and a high-frequency generator, together with a score or two or other uses in electrical engineering: it will serve also as a musical instrument, an instrument of astounding possibilities.

It is quite possible, I believe, that the musical audion, when fully developed and perfected, will revolutionize altogether the production of music. It will supersede our organs and pianos, even perhaps our symphony orchestras, just as these have superseded the musical instruments of ancient times, the lyre, the tambor, and the Pipes of Pan.

This musical phase of audion possibilities is not a new idea, though it is one long awaiting development. Back in 1915, following the use of the audion in the record-breaking radio telephone demonstration from Arlington to Honolulu, I made an announcement of what was then the promise of an early use of this magic tube as a producer of music. I pointed out that the tube was a device capable of producing musical notes of rare beauty and great range; an entirely new music of surpassing volume and harmony.

It was while developing the audion as a wireless telephone detector, and as an amplifier to be used on long-distance telephone lines, that I made the discovery of audion music. I found that when the circuits of an audion tube were adjusted in a certain way, so that electrical oscillations were produced, I could hear a clear musical note in the connected telephone receiver. The quality of this note was exceptionally beautiful. After later experiments I found that I could change this quality of tone so as to produce a great variety of sounds—imitating, for example, the flute, the oboe, the cornet or stringed instruments. I could also produce other sounds which, while pleasing to the ear, were quite unlike the tones emitted by any of the musical instruments with which we are familiar.

The pitch of the note could be regulated, I found, by changing the capacity or the inductance of the circuit, this being accomplished easily by means of a sliding contact on the inductance coil or



From a photo made for POPULAR RADIO by Western Electric

PHOTOGRAPH OF THE NOTES OF A FIFE

This oscillograph shows (at the top) a pure sine wave of 1000 cycles a second; the second wave from the top shows the highest note of the fife, which has practically no harmonics. The presence of harmonics is clearly shown on the two lower waves.

by turning the knob of the condenser. I found, indeed, that I could change the pitch of the note by merely touching my finger to certain parts of the circuit, and by so doing I was able to obtain many weird and beautiful sound effects. Another method of varying the pitch was by means of a black lead pencil mark drawn on a piece of paper or a slate and connected across certain parts of the circuit.

Every one is familiar with the peculiar plaintive notes produced by the Hawaiian guitar when the player slides a piece of steel along a string previously set in vibration. Much the same effect can be obtained with the musical audion by varying gradually the pitch of its note. Other effects include the shrill warble of birds, staccato drumbeats, heavy organ peals and notes closely simulating those of the familiar orchestral instruments. Even in our preliminary experiments we succeeded in producing new tones, tones far more ethereal and beautiful than any now at the command of musicians.

The reason why these effects were possible will be clear at once to radio engineers. Musical tones are simply air vibrations or oscillations that have frequencies within the audible range. That is, they have what we call "audio frequencies." On the other hand, the electric oscillations in a vacuum tube, for example in a tube which is being used as a generator of oscillating current or as a transmitter for continuous wave radio work, are much more rapid than the oscillations of sound. They have higher frequencies or what we call "radio frequencies." All this is familiar.

But vacuum tubes can be made to oscillate not only at the high radio frequencies, but also at the much slower audio frequencies. This, indeed, is just what the tube does when it goes wrong temporarily and howls into the telephones of a radio receiving set. It is oscillating at a comparatively low frequency, a frequency within the audible range.

All that we have to do to bring this about artificially is to arrange a partial feed-back circuit containing the proper inductances and capacities to produce just the frequency, that is, the tone, which we wish. The electric oscillation thus produced, being already of audio frequency, requires merely to be fed into a telephone or loudspeaker in order to give us ordinary sounds in the form of a musical tone.

The note of an organ pipe is produced by the oscillation of the air-column inside the pipe. The note of an audion tube is

George Granthans Bain

HOW THE "AUDION ORGAN" MAY BE PLAYED

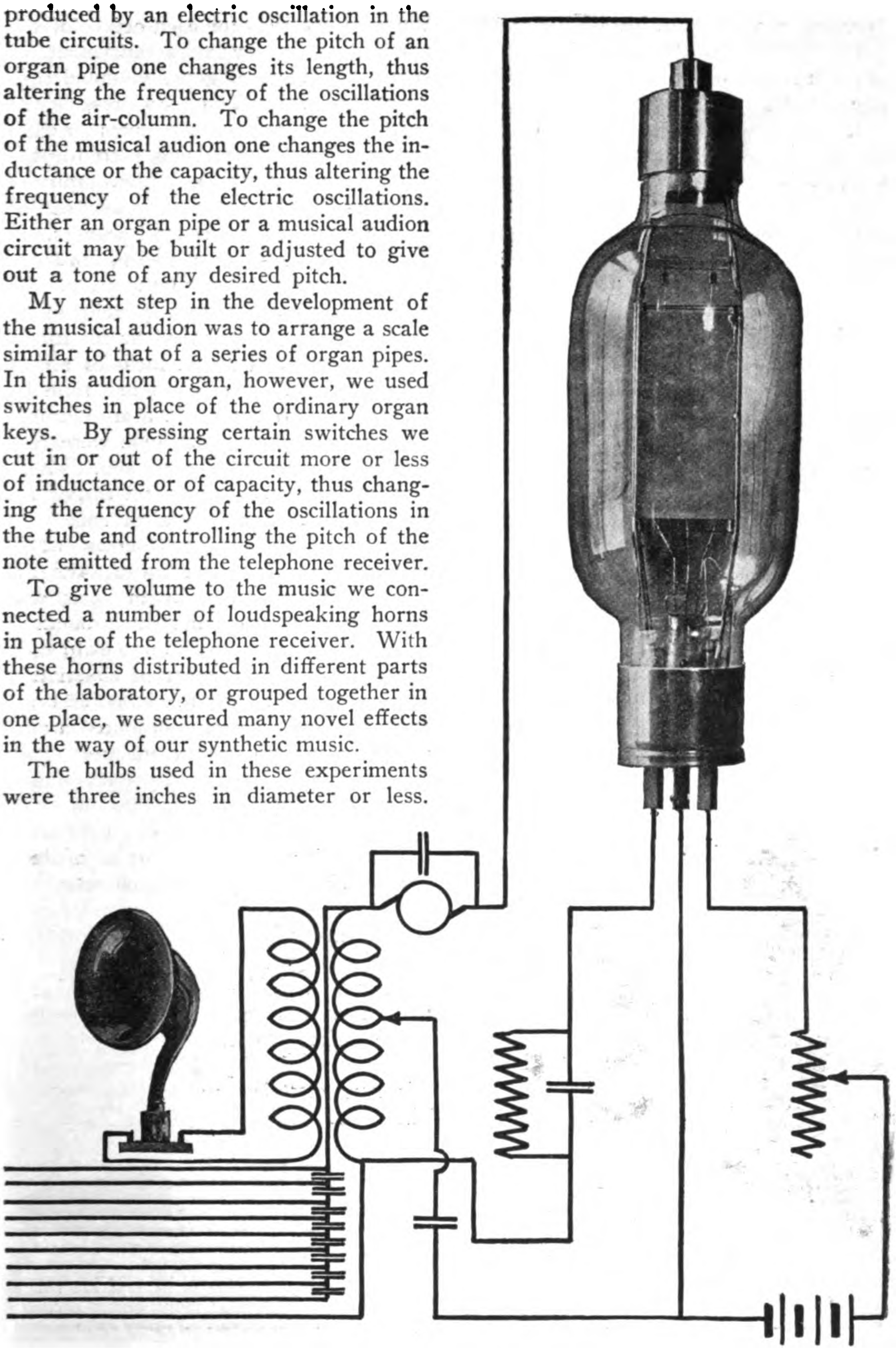
By means of vacuum tubes, a loudspeaker, and a suitable audio frequency oscillating circuit connected to a keyboard—similar to a piano or organ—music of exceptional tone flexibility and wonderful sweetness may be produced. The apparatus may be controlled by "stops" as in the organ, so that the various musical instruments may not only be imitated, but other tone qualities may be produced that are unknown to the musical world today.

produced by an electric oscillation in the tube circuits. To change the pitch of an organ pipe one changes its length, thus altering the frequency of the oscillations of the air-column. To change the pitch of the musical audion one changes the inductance or the capacity, thus altering the frequency of the electric oscillations. Either an organ pipe or a musical audion circuit may be built or adjusted to give out a tone of any desired pitch.

My next step in the development of the musical audion was to arrange a scale similar to that of a series of organ pipes. In this audion organ, however, we used switches in place of the ordinary organ keys. By pressing certain switches we cut in or out of the circuit more or less of inductance or of capacity, thus changing the frequency of the oscillations in the tube and controlling the pitch of the note emitted from the telephone receiver.

To give volume to the music we connected a number of loudspeaking horns in place of the telephone receiver. With these horns distributed in different parts of the laboratory, or grouped together in one place, we secured many novel effects in the way of our synthetic music.

The bulbs used in these experiments were three inches in diameter or less.

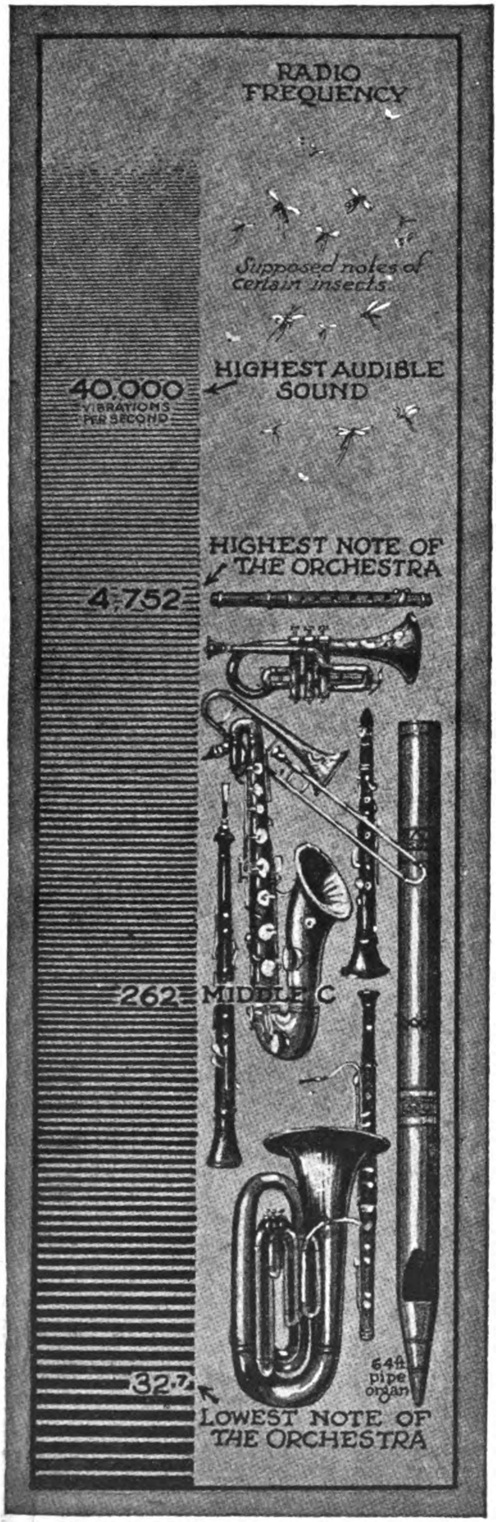


We used one bulb for each octave of the musical scale. By an arrangement of switches in place of keys, we could produce from this one bulb, by pressing the right switch, any of the notes of that octave. Another bulb was used for the next octave, and so on. The output of all these bulbs was fed into one set of telephone receivers or loudspeakers, so that the total energy emitted in the form of sound was that of all the circuits in action at any one time. It included all of the notes being sounded by the tubes, just as orchestral music includes all of the notes being sounded at one time by all of the instruments which are playing.

These experiments of mine were carried out six or seven years ago. There had been, however, some still earlier attempts to produce electrical music in other ways, not using the audion. Notable among these were the experiments of the Cahil Company with what was called the "telharmonian."

This instrument was a huge plant consisting of a large number of alternating current generators of the inductor type. Each of these generators produced a current of a certain definite number of alternations a second, and each was tuned to the frequency of one of the notes of the musical scale. There was a different generator for each note, just as a piano has a different string for each note.

The currents from these generators were controlled by a keyboard similar to that of an organ and were combined thus into a single, highly-complex musical current which was transmitted over the telephone wires to theaters, hotels and homes, where loudspeaking horns poured this new electrical music into the air. There were imitations of the organ, the


RADIO FREQUENCY
Supposed notes of certain insects
HIGHEST AUDIBLE SOUND
40,000 VIBRATIONS PER SECOND
HIGHEST NOTE OF THE ORCHESTRA
4,752
262
MIDDLE C
64 ft pipe organ
32.7
LOWEST NOTE OF THE ORCHESTRA

LOWEST AND HIGHEST SOUNDS PERCEPTIBLE TO THE HUMAN EAR

Of the thirty instruments of the modern orchestra, the lowest pitch is that of the tuba (32.7 vibrations a second), and the highest is that of the piccolo (4,752 vibrations a second). Radio frequency currents in general use range from 30,000 to 1,500,000 vibrations a second; the highest audible vibrations range up to 40,000.

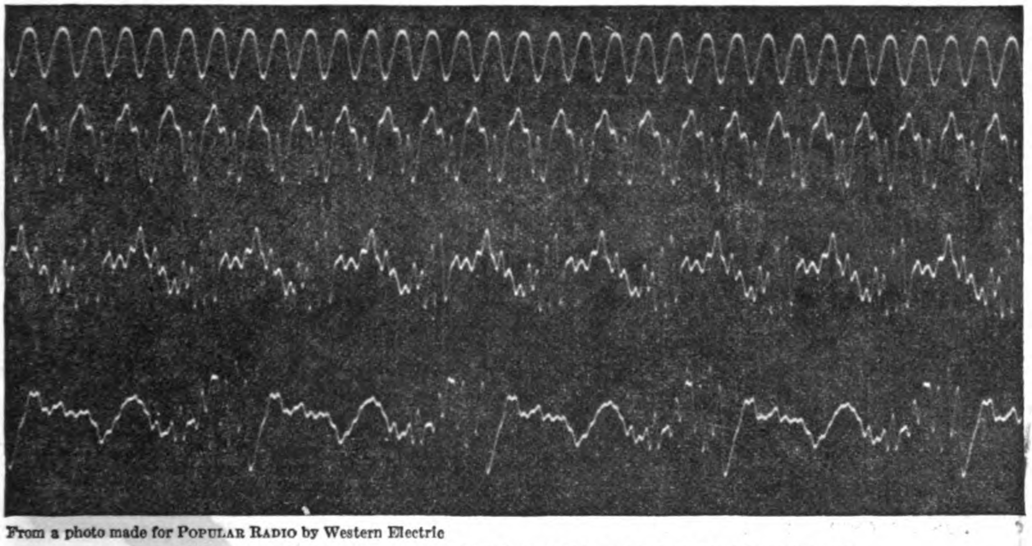
clarinet and other instruments, and mingled with these were strains of a quality entirely novel to musicians.

In comparison with the telharmonian, the musical audion has the advantages of greater flexibility and ease of control as well as of simplicity. As a source of musical tones an audion is equivalent to, indeed it is superior to, the alternating current generator, but at a small fraction of the cost, bulk and weight. The necessary parts of an audion organ might be contained in the cabinet of an ordinary talking machine and with a control the size of a typewriter keyboard. With the audion organ there are no pipes or strings to require great bulk, and yet it will produce music ample to fill a large auditorium.

The greatest advantage of the audion organ lies, however, in the increased tonal resources which it puts at the service of the musical composer. Musical tones differ among themselves in three qualities: pitch, loudness and quality. The pitch is simply a matter of frequency; the greater the frequency, the higher the pitch. Loudness explains itself; tones may be either very strong and loud, or very faint—or anything in between. Both of these two characteristics of a tone are fully controllable in the audion organ; pitch, as I have explained, by varying the frequency of the electric oscillation, loudness by varying the input of energy with a resistance or in any other convenient way.

But the third characteristic of tones, the tone quality, the audion organ also permits us to control; and it is this, I imagine, which will be of the most interest to the professional musician.

The differences in the sound of the various musical instruments are due almost altogether to differences in the quality of their tone. Middle C of the piano has a pitch or frequency of 262 vibrations a second. This same note played on a violin or on a clarinet or on a French horn has exactly the same frequency, 262 a second. Yet the notes from these different instruments do not sound alike. You can tell easily that one of the notes is from the piano, another from the French horn. What are the differences?



From a photo made for POPULAR RADIO by Western Electric

THE TONES OF A SAXOPHONE—THE INSTRUMENT RICHEST IN HARMONICS

Compare the record of harmonics (illustrated by the frequencies in the three lower waves that record three different notes of a saxophone) with the pure sine wave at the top.

They lie in the tonal quality, and this tonal quality is a matter of what are called "overtones." A pure musical tone is a simple and regular vibration. It is represented by a pure sine-wave curve, like the curve of a perfectly regular alternating current.

Incidentally, such an absolutely pure tone cannot be produced by any ordinary musical instrument and only with great difficulty by the human voice. All ordinary musical tones contain certain overtones superposed on the pure tones. These overtones are tones of higher pitch, that is, of higher frequency, which are sounded at the same time as the pure tone and blend more or less completely with it. The overtones produce little bumps and hollows, little kinks, in the sine-wave of the pure tone. Or they displace the maxima and minima of the wave, so that the original sine-wave is no longer exactly even and symmetrical. In electrical language they "distort the wave of the sound."

This distortion is what produces tone quality. A piano note has a certain fundamental tone, a pure symmetrical sine-wave, corresponding to the pitch of the note. It also has certain overtones, corresponding to vibration of the piano string in parts, in halves or thirds or quarters. It has certain other overtones, corresponding to parts of the sounding-board or to other strings. The actual tone is the sum and combination of all these tones. The overtones distort the sine-wave of the pure tone. They give it its quality, so that you recognize it as a piano tone. If your ear is very good you may be able even to recognize it as a tone from a certain individual piano or from a piano of a certain make.

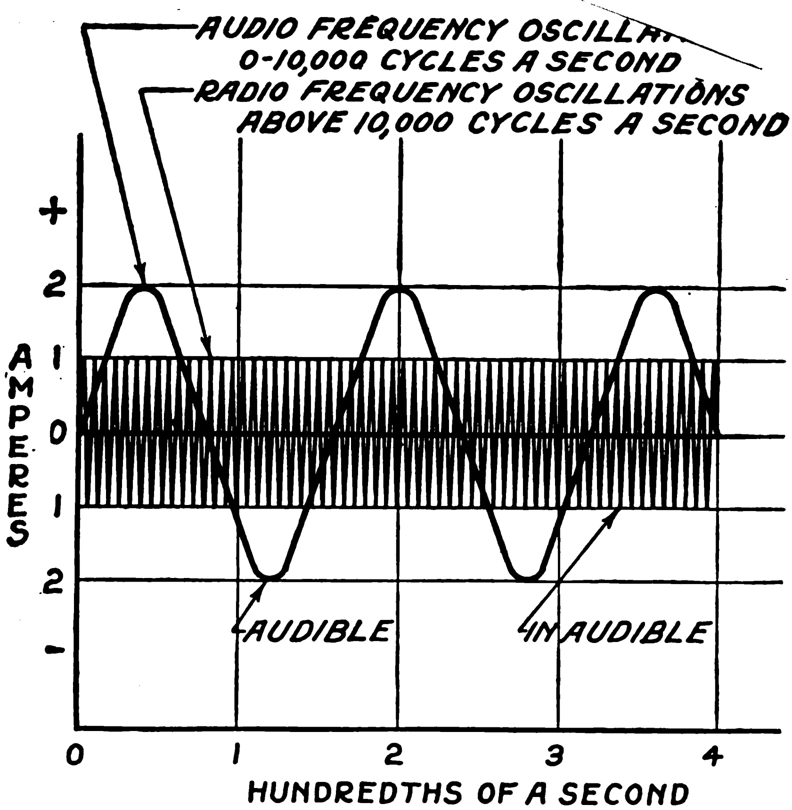
Similarly with other instruments, each one has its own set of overtones which it imparts to its fundamental tone. Each one has its own tone quality. To some extent this quality can be controlled by the musician, as when a violinist changes his tone quality by varying his bowing, or when a horn player sticks his fist into the bell of his instrument in order to get the so-called "stopped" quality into his tone.

Now all of these variations of tone quality are obtainable—and controllable—with the audion organ. The musical audion may be adjusted so that its primary tone is absolutely pure, a perfect sine-wave. Or this primary tone may be altered merely by distorting the electric circuits, so as to cause any desired change in the quality of the sound. It may be made to counterfeit the piano, the violin, the 'cello or the horn, or may be distorted into any sort of sound—musical or grotesque.

Furthermore, the note of the audion tube is controllable in pitch with extraordinary precision. It may be altered not only in steps of a full tone (as in most instruments), but by half tones or quarter tones or even lesser fractions. It may be played so as to be always precisely in tune, an advantage which it shares only with the violin and other bowed strings and with the slide trombone. All other instruments, among ordinary ones at least, have a fixed series of notes. Only these notes can be played, and the musician can alter the pitch of these, while playing, only slightly, if at all.

On the piano, for example, D sharp and E flat are the same tone, produced from the same string. Every musician knows that this is not quite as it should be. D sharp and E flat ought to differ a little in pitch. One or the other should be used depending upon the exact harmony desired. But to insert both in the piano would require too many strings and keys. One note, about half way between the two, must serve for both. The entire piano keyboard is a compromise between musical desirability and mechanical necessities. Its scale is not, it cannot be, exactly perfect.

Other instruments have similar imperfections. Their scales are never quite perfect. Their harmonies are always a trifle untrue. Only the violin and its lower-pitched analogues, the viola, the



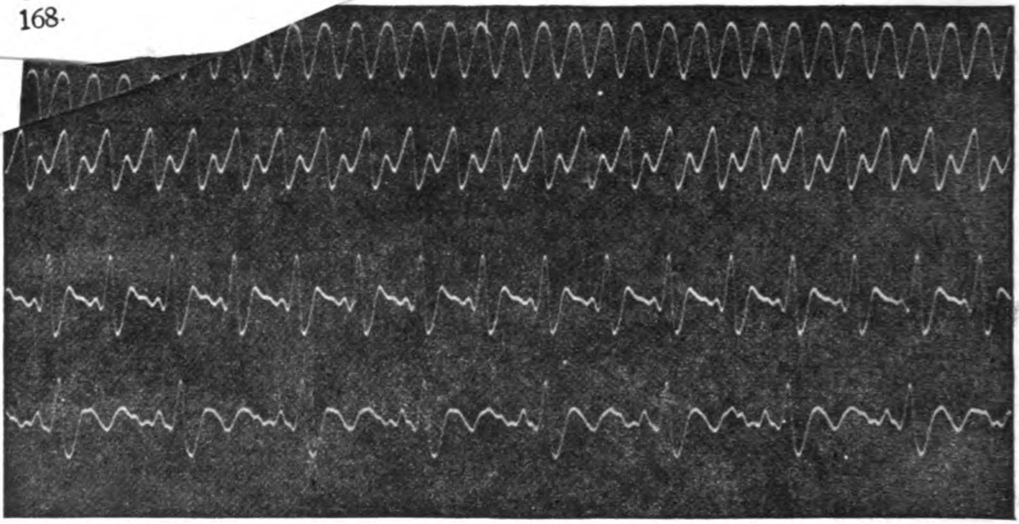
VIBRATIONS THAT WE CAN HEAR—AND THAT WE CANNOT

This diagram shows two alternating current waves. One is one of a frequency that we can hear and one is of a frequency that oscillates so fast that the human ear cannot detect it. The latter is used in radio communication and is usually produced by the vacuum tube. The vacuum tube may also be used to produce the audio frequency oscillations which are used by De Forest for the production of the wonderful new music described in this article.

'cello and the double bass; the slide trombone; the human voice—and the audion tube—can be made to produce absolutely true tones, absolutely perfect harmonies.

In precision of control for both pitch and tonal quality, the audion tube equals or surpasses all other instruments. It has, as the musicians say, great flexibility, a flexibility exceeding even that of the full orchestra.

The modern symphony orchestra contains 25 to 30 kinds of instruments. Allowing for the possible different ways of playing some of these instruments, the composer has at his service perhaps one hundred different kinds of tonal quality. His available pitch range is from the highest D of the piccolo, at 4,752 vibrations a second, to the lowest C of the mutiple-valved tuba, at 32.7 vibrations a second. He can widen this pitch range a few notes if he has an organ for very low tones or if his violinists can play the six or seven possible harmonics which range above the piccolo. But his available range of tone quality and his available range of pitch do not fully coincide. He cannot play high notes of bass-horn quality nor low notes that sound like the piccolo or flute. The flexibility of the orchestra, its resources of tone color, or expression or emotional portrayal, while very great in comparison with the piano or with any other single instrument, is still far from being as complete as is possible in theory.



From a photo made for POPULAR RADIO by Western Electric

PORTRAIT OF THREE NOTES OF A CORNET

Note the first harmonic (one octave above the fundamental) in the wave below the pure sine-wave. In the record next below there are numerous harmonics which are increased further in the lowest wave.

The whole history of instrumental music may be regarded, by the way, as a more or less successful effort by musicians to widen the flexibility of their instruments, to increase the sum-total of their tonal resources. The original instruments of primitive man appear to have been two, the simple pipe or whistle and the drum. To these the ancients added a third fundamental instrument, the stretched string or lyre. These three possessed a very small range of pitch and a still smaller range of tonal quality.

It was the effort to increase this range that led to modern instruments. Out of the pipe grew first the notched or holed pipe which could play several notes and which survives in the modern flute. Then came the combination of several pipes fastened together in a row. These could play not only a note for each pipe, but the quality could be varied by using narrower and wider pipes or by making them out of different materials. Hence the Pipes of Pan or syrinx; and out of this there came, by direct and traceable descent, the modern organ.

The primitive stringed instrument, the lyre, developed even more widely in the direction of greater flexibility. Pitch range was attained by the device of changing the string length with a moving finger, as in the modern violins. A marvelous increase in range of tonal quality followed the invention of the bowed or scraped string to replace the original plucked string.

Even the drum followed suit in the search for greater flexibility. We have now the tuned drum or kettledrum, the various tone qualities of small drum, base drum and tambourine, and, in addition, the triangle, cymbal and others, which are really only kinds of drums made out of metal, and made thus in order that the tone quality might be different, that the composer's available range of quality might be widened still a little farther.

Finally, we have the modern orchestra, its available musical resources so wide that they would have been totally inconceivable, I suppose, to a musician of ancient Greece or Rome, even perhaps to the religious choristers of only two or three centuries ago.

Is this the final step? Has the orchestra as wide a range of pitch and tone quality as we will ever be able to attain?

I think not. I believe that the musical audion will soon be able to widen greatly even the great flexibility of the orchestra. Audion tubes can play notes of any pitch; even, if necessary, notes several octaves above the piccolo or the violin harmonics. And they can play all of these notes, high or low, with any desired tonal quality; with the quality of horn or oboe or 'cello, or with new qualities not yet known or used.

What a resource for the composer! What possibilities of new orchestration, of undreamed of harmonies and melodies, tone colors and emotional effects!

Of course we must not expect that the development of the audion organ will be entirely free from practical difficulties. At least two of these difficulties can be foreseen already. One is that of arranging a tube circuit which will be perfectly stable, so that the tone of the tube will not vary, even ever so slightly, after it has been once adjusted.

The second difficulty is the devising of a precise, rapid and dependable system of control, an equivalent of the keys and valve mechanisms of the ordinary organ. Mere switches and condenser knobs are neither precise enough nor quick enough.

At the moment these practical obstacles look pretty serious. But obstacles have a way of disappearing as we approach them more closely, especially where the audion tube is concerned. Probably obstacles to the development of the audion organ will be no exception.

In all my work with the audion—and I can imagine no device in the wide range of practical physics which has greater fascination than this little bulb—I have found no phase of its possibilities quite so interesting as this one of the production of musical tones. Certainly the idea of producing beautiful tone effects by such an entirely new method, unknown to our great composers, offers to musicians an alluring field for their genius.

In the audion we shall have an instrument suitable for home entertainment as well as for furnishing music to a big auditorium. And music thus produced may be taken up again by the audion, this time for broadcasting, and finally received by the countless other audions of receiving sets throughout the world. The musical audion, the radio transmitting audion and the receiving audion, each one doing its share toward the enrichment of life!

The Master's Voice

Our esteemed (if somewhat more elderly) contemporary, the London *Punch*, recently published a satirical drawing of a Vicar and a Verger regarding an empty church.

"This is terrible," observed the former, "five minutes before the service and not a soul here!"

"No, sir," replies the Verger, "but I understand there are some thousands waiting in their own homes to listen in."

In the United States the satire of this observation would be lost—simply because it reflects a truth. The accompanying picture was snapped in a Pennsylvania farmhouse during divine service by radio.

From a photograph by P. A. Sensenig

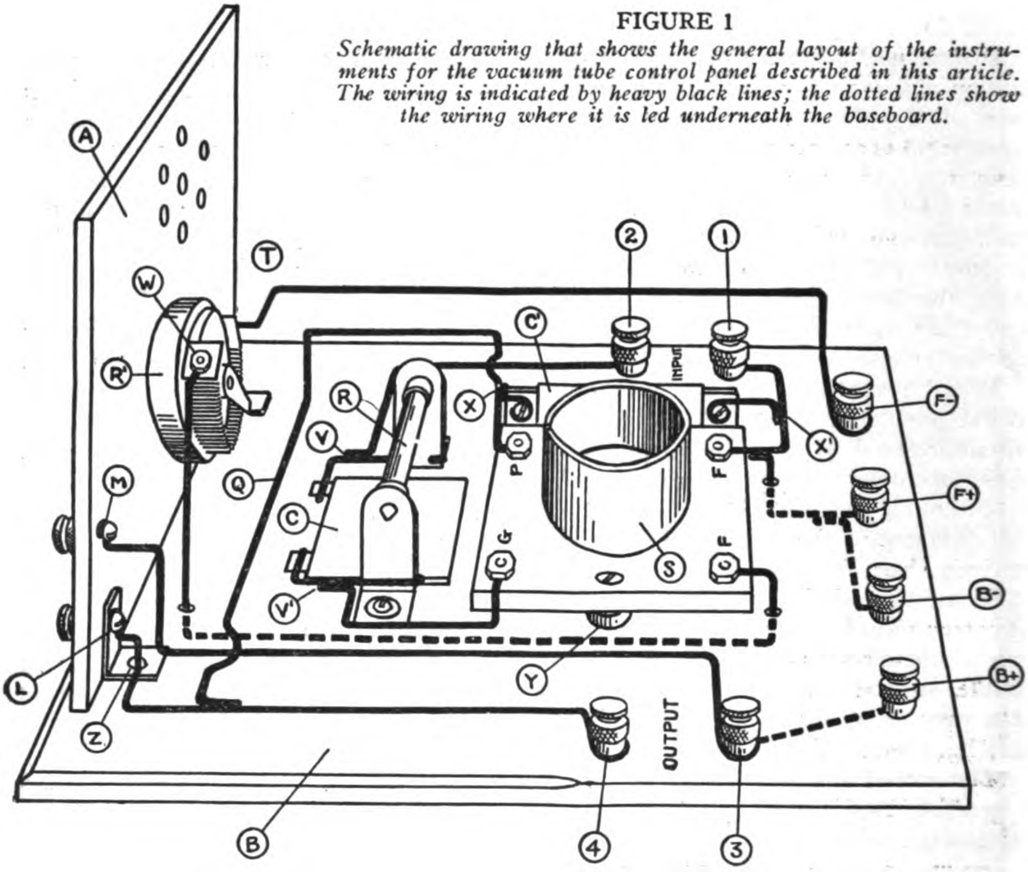


FIGURE 1
Schematic drawing that shows the general layout of the instruments for the vacuum tube control panel described in this article. The wiring is indicated by heavy black lines; the dotted lines show the wiring where it is led underneath the baseboard.

How *to* Add a Vacuum Tube *to* Your Crystal Receiving Set

THE COST OF DOING IT—

Item	Cost
Electron tube	$5.00 to $6.50
Electron tube socket	.75 to '2.00
Filament rheostat	1.00 to 2.50
Grid leak and grid condenser	.50 to 1.50
By-pass condenser (about)	.35
Ten feet No. 14 bare tinned copper wire (about)	.10
Miscellaneous binding posts and screws (about)	.75
"A" storage battery, 6-volt, 60 ampere-hour capacity	15.00 to 20.00
"B" battery, 22½ to 45 volts	1.00 to 3.00
Total cost	$23.25 to $36.70

By WATSON DAVIS

THOSE radio fans who made the crystal receiving sets that have been developed by the Bureau of Standards in Washington and that have been described in detail in this magazine,* have apparently found their modest experience with radio so interesting as to stimulate a desire for a receiving set of greater efficiency. In response to this demand, Uncle Sam has produced another set of specifications—a new and better set that employs the same tuning inductances as the two previous sets but that substitutes a vacuum tube detector for the crystal detector.

These new specifications enable the builder of the crystal sets to convert them into tube sets at a cost ranging from $23.00 to $37.00. Thus altered, the new sets are capable of receiving high-powered transmitting stations at a distance of about seventy-five miles, when they operate on wavelengths from 200 to 600 meters. Under good atmospheric conditions broadcasting from distant stations may be heard, especially at night. The simple electron tube detector circuit will not, however, make "continuous-wave" signals audible.

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*See "How to Make and Install Your Own Receiving Set" in POPULAR RADIO for May, 1922, and "How to Make and Operate a Two-Circuit Receiving Set" in the July issue.

The instructions issued from Washington describe simple apparatus of satisfactory performance without reference to the possible existence of any patents which might cover parts of the apparatus. Apparatus in general similar to that described can be purchased from responsible manufacturers and dealers.

The Essential Parts of the Set

The complete radio receiving equipment may be divided as follows: antenna, lightning switch, ground connections and telephone receivers. These are completely described in the May issue of this magazine.

The tuning device. This may be the tuning coil described in the May issue of POPULAR RADIO or it may be the two-circuit coupler and variable air condenser described in the July issue. While the two-circuit tuner will be somewhat more selective than the single-circuit tuner, its use is not absolutely essential. The two-circuit tuner is also more difficult to operate than the single-circuit tuner.

The electron tube detector unit. This is shown in Figures 1, 5, and 6. It is composed of a baseboard B and an upright panel A. On the baseboard B is mounted an electron tube E, shown only in Figure 5, an electron tube socket S, a grid leak R, a grid condenser C, a by-pass condenser C^1, and eight binding posts. On the upright panel A is mounted a filament rheostat R^1, (the adjusting knob J is shown in Figure 5), and two telephone receiver binding posts L and M. The parts S, R, C and C^1 are also shown in Figure 3. Later it will be told how the various parts are assembled on the baseboard and the panel. No description is given of how the parts E, S and R^1 are made because these are all commercial articles. It is, of course, possible for one to make parts such as the electron tube socket S and the filament rheostat R^1.

The accessories needed are a six-volt battery, used for lighting the filament, often called the "A" battery, with an ampere-hour capacity of about 60; a 22½ to 45-volt dry battery, called "B" battery; binding posts; stiff copper wire; wood boards for the baseboard and upright panel, and two brass angle braces for supporting the panel. The "A" and "B" batteries are shown in Figure 5. The "A" battery will usually be placed on the floor beneath the table upon which the other parts of the equipment are mounted. Its comparative size is much reduced in the drawing. An insulating material panel may be substituted for the wood if desired. The electron tube detector may also be entirely enclosed in a wood cabinet with a hinged cover, if desired.

Details of Construction

The baseboard (See B, Figures 1 and 3). The base B is any kind of dry wood about 6¼ inches by 8¼ inches by ¾ inch thick. Eight holes are drilled through the base in which the binding posts are fastened. The spacing of these holes is shown in Figure 3. By the addition of two more binding posts properly connected, this detector may be used in a "regenerative" circuit when the binding posts are externally connected to a "tickler" coil coupled to the tuner. These binding posts are added to the detector baseboard B in line with the "input" binding posts Nos. 1 and 2. (See Figure 1.) They are 7/32 inch from the edge of the baseboard, and the four binding posts are arranged in such a manner that they are equally spaced, 1½ inches between centers. Referring to Figure 1, the wire which leads from the terminal P of the electron tube socket is cut at some convenient place Q and the two ends thus formed connected to the extra binding posts. The method followed in making these connections does, of course, correspond with the style of wiring used in the complete electron tube detector unit. The connection X, from one terminal of the condenser C^1, is also removed and a longer wire connected from this terminal to the other side of the point Q where the wire was cut. The base is arranged so that the three remaining sides and a hinged cover may be added without changing the relative positions of the binding posts. Under each of the four corners of the base B, rubber or wood feet or risers are fastened to protect the binding post heads and wiring on the under side of the base.

The upright panel. (See A, Figures 1 and 2.) The panel A is any kind of wood about 4½ inches by 5 inches by ⅜ inch thick. In Figure 2 a back view of the panel is shown which brings the two holes for the telephone receiver binding posts in the lower left-hand corner. If the panel is viewed from the front these two holes will be at the lower right-hand corner. It is desirable that this board present a good appearance, as it is the front panel. Four holes are drilled in the panel A, one for the bolt which fastens the panel to the brace (see L, Figure 1), two for the telephone receiver binding posts L and M (Figures 1 and 5) and one for the shaft of the filament rheostat R^1 (see Figure 1).

The exact location of the hole for the rheostat shaft is determined from the rheostat itself. It is drilled so that the rheostat will occupy as low a position as possible, allowing room enough to do the necessary wiring.

The electron tube. (See E, Figure 5.) The electron detector tube is a commercially available type. An electron tube is sometimes called a vacuum tube or audion.

The electron tube socket. (See S, Figures 1, 5, and 6.) The electron tube socket is of commercial design.

The grid leak and grid condenser. (See R and C, Figures 1, 3, 5, and 6.) The grid leak and grid condenser may be purchased together or separately or they may be constructed. If one expects to use a detector type of electron tube (sometimes called "soft" or "gas" tube) it is recommended that these two parts be purchased with the tube, care being taken to select the proper values of resistance and capacity for the grid leak and the grid condenser, as specified by the manufacturer of the tube purchased. The resistance of the grid leak will usually be between 1 and 5 megohms (1,000,000 and 5,000,000 ohms) and the capacity of the grid condenser will be about 0.0003 of a microfarad (300 micro-microfarads). If an amplifier type of electron tube (sometimes called a "hard" tube) is used, the resistance of the grid leak may generally be anywhere within the resistance limits specified above and the same size of grid condenser used as mentioned above. Experimental grid leaks may be made for such electron tube detectors. This is only suggested for its educational feature. If the two-stage audio-frequency amplifier is used also, it will be difficult to make a grid leak that will work satisfactorily. Such an experimental grid leak may be made from a piece of fiber about ⅜ inch wide, 1½ inches long and from 1/32 to ⅛ inch thick. Two ⅛-inch holes are drilled along the center line of the piece, about an inch apart. A line is drawn between the two holes, using India or drawing ink. Contact with the ink line may be made by the use of two brass (6-32 or 8-32) machine screws about ½ inch long and each equipped with one nut and two washers. The machine screws are put through the holes in the ends of the fiber strip with one washer on each side of the fiber strip. A small piece of tinfoil may be rolled up and wound around each machine screw between the fiber and the washer so that the tinfoil pad will make contact with the ink line. When the nuts are tightened down, the tin-foil pads will flatten out and form a contact between the

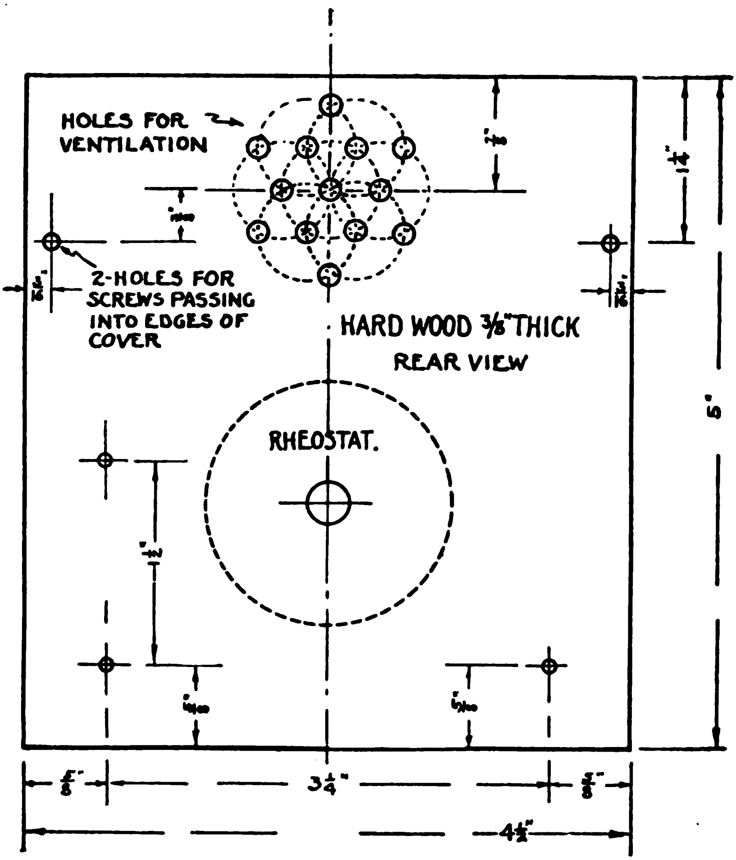

FIGURE 2

This diagram illustrates in detail how to bore the holes in the upright panel "A."

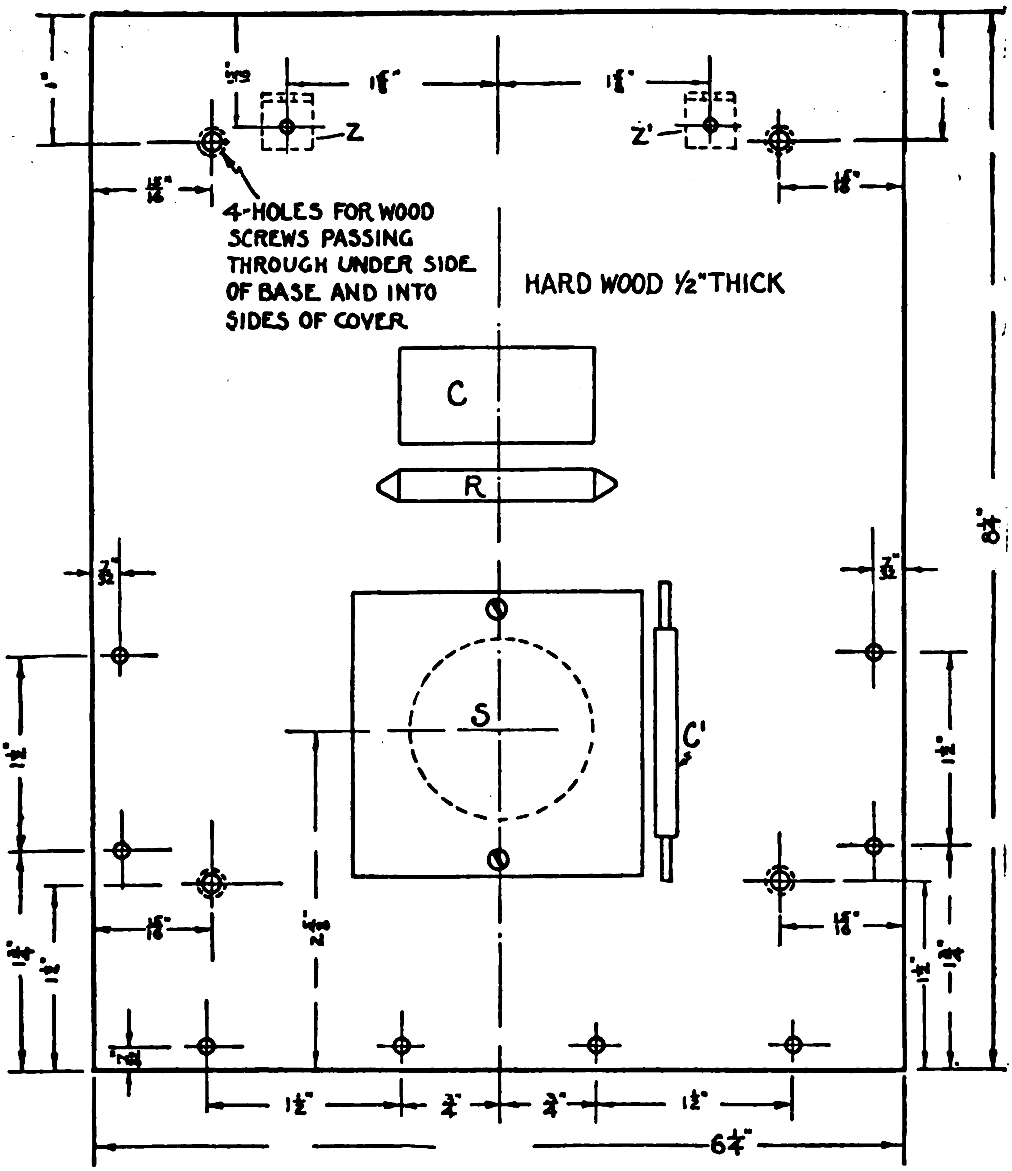
Z
Z'
4-HOLES FOR WOOD SCREWS PASSING THROUGH UNDER SIDE OF BASE AND INTO SIDES OF COVER
HARD WOOD ½" THICK
C
R
S
C'
1½"
¾"
¾"
1½"
6¼"

FIGURE 3

A plan view of the baseboard "B"; it indicates where the parts used should be placed and tells the amateur builder where to drill the holes for the binding posts and other parts.

brass washers and the ends of the ink line. Since the ink line makes a partial electrical conductor of high resistance, the thickness and width of the ink line will determine the resistance of the grid leak to a great extent. The value of resistance may be decreased by inking the line over several times, until the electron tube detector works best.

The by-pass condenser. (See C¹, Figures 1, 3, and 6.) This is any small-sized fixed condenser with a capacity of from 0.0003 to 0.0015 of a microfarad (300 to 1500 micro-microfarads) which may be purchased.

The binding posts. (See Figures 1 and 6.) The binding posts used on the base may be 6-32 or 8-32 brass machine screws each equipped with two nuts and two washers, if regular binding posts are not available. The telephone receiver binding posts, L and M (Figure 5), should be of the set-screw type

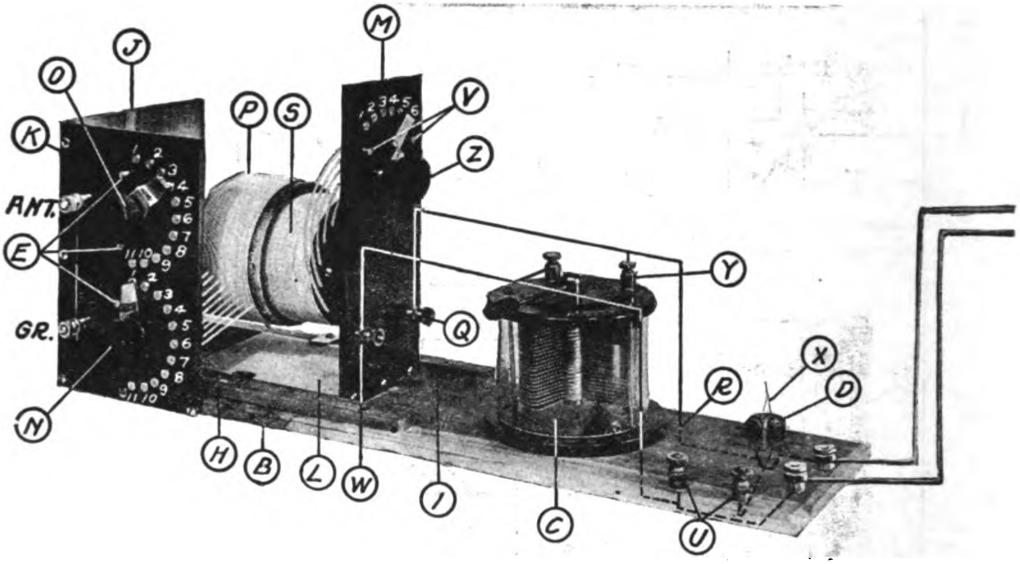

FIGURE 4
This shows how the two additional binding posts are connected to the set described in our July issue, with the two wires connecting it with the vacuum tube detector shown in Figure 5.

to admit the tips of the telephone receiver cords.

The filament rheostat. (See R¹, Figure 1.) As has been previously stated, the filament rheostat may be constructed but no details are furnished. If the rheostat is purchased, it is desirable to select one designed for panel mounting as well as one that has a neat-appearing knob and pointer. The rheostat should have a resistance of about seven ohms and a current-carrying capacity of about 1½ amperes.

Accessories. The accessory batteries are commercial articles. The purchaser of a storage battery for lighting the filaments should get full instructions from the dealer for testing and recharging the battery. The dry "B" battery usually used for the plate circuit can not be recharged. The normal life of a battery of reliable manufacture is about six months. Storage batteries for use as "B" batteries are available. The first cost is greater than that of dry batteries, but they may be recharged.

Assembly and Wiring

Wood finish. It is essential in electron tube sets that the wood be protected from moisture. While the wood base and panel may be treated with paraffine it is found more satisfactory to dry the wood first and then stain and varnish it, using a good varnish, preferably an insulating varnish. Shellac is not recommended. It is difficult to give definite suggestions concerning drying and staining of wood. Wood may be put in a warm oven for an hour or so to insure more or less complete drying. A lamp-black or carbon pigment stain is not used ordinarily on such radio parts, since it is better to avoid the use of such. The stain and varnish are thoroughly dried before the apparatus is mounted on the wood baseboard and panel.

The baseboard. (See B, Figures 1 and 5.) The eight brass machine screws or binding posts are put in the holes already drilled in the baseboard. If machine screws were to be used the heads would be put on the under side of the baseboard with a brass washer between the head and the baseboard. A brass washer and two nuts are then fastened to each screw on the upper side of the baseboard, with the washer next to the baseboard. The tube socket S, the grid condenser C, the grid leak R and the by-pass condenser C¹ are next screwed to the baseboard. (Certain types of condensers, will be held in position by the wiring only.) The exact location of these parts cannot be stated because the several types of parts commercially available will vary somewhat in dimensions. One can get a very good idea of the relative positions of the several parts from Figures 1, 3, and 6. The tube socket S is mounted so that the two terminals marked G and P (Figure 1)are nearest the upright panel. Blocks Y and Y¹ are put under the socket S so that the four terminals of the socket do not touch the wood baseboard. This is done by cutting off two round wood blocks just long enough to raise the socket terminals clear of the base, and mounting them so that the screws which hold the socket to the baseboard will pass through holes in the centers of the blocks. After the socket S, grid condenser C, grid leak R and by-pass condenser C¹ are mounted the parts are wired up. No. 14 bare tinned copper wire is used in wiring. This makes the connections stiff and self-supporting. This wire

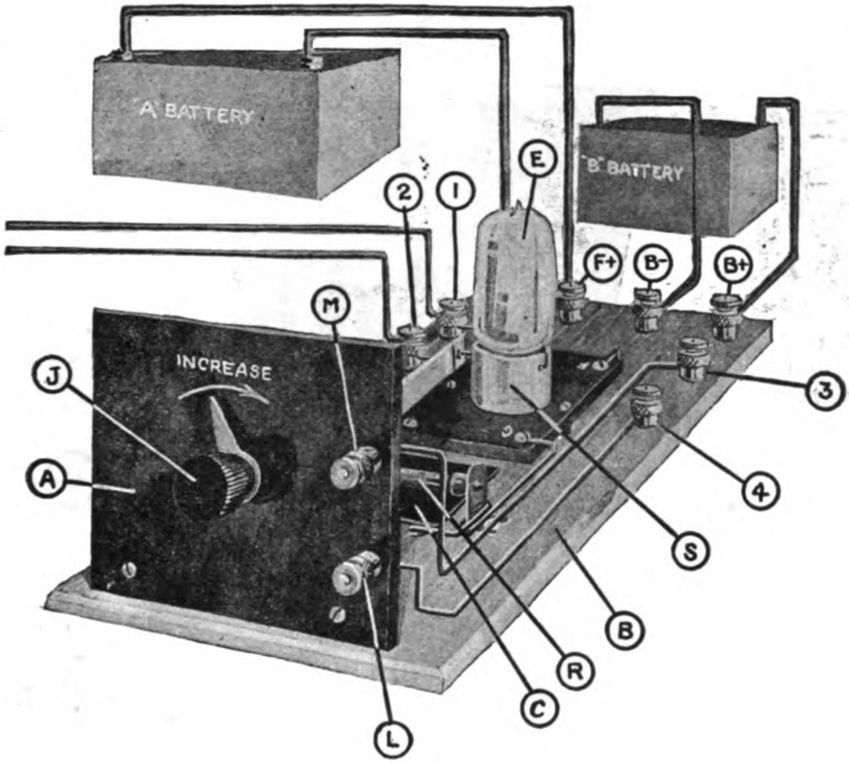

FIGURE 5

The vacuum tube control panel connected up with the necessary "A" and "B" batteries, as they are used to increase the receiving range of the set shown in Figure 4 opposite. This control panel (containing the vacuum tube detector) is merely substituted for the crystal detector that is ordinarily used with the set on the page facing.

is ordinarily furnished in rolls. The wire should be straightened before it is used. It can be straightened by clamping or otherwise fastening one end solidly and pulling on the other end just hard enough to stretch the wire slightly. It is also a good plan in wiring such sets to have all wires run as directly as possible, neatly, and all bends made at right angles. When a wire is attached to a binding post, a loop or eye is formed on the end of the wire and the wire at the eye flattened with a hammer. This gives more contact surface. Special lugs may also be soldered to the ends of the wire before the connection is made. A small hole is drilled through the baseboard just back of each of the tube socket terminals marked F (see Figure 1). A short piece of wire is fastened to the right-hand socket terminal marked F and is then led through the small hole in the baseboard to the under side of the baseboard. The same wire is led to the binding post F and fastened between the machine screw head and washer underneath the baseboard. The same wire is further led to the binding post marked B and fastened between the machine screw head and washer underneath the baseboard. All wires which are run on the under side of the baseboard are shown by dotted lines. A short piece of wire is soldered to the wire leading from the right-hand socket terminal marked F, just above the baseboard and led to the "input" binding post No. 1 and fastened between the washer and the first nut. This wire is shown as a solid line which means it is on the upper side of the baseboard. The wires do not touch the wood boards except at the terminals and where the wires pass through holes in the baseboard. The wires may all be raised more or less to accomplish this. The two terminals of the grid condenser C are connected to the two terminals of the grid leak R as shown in Figure 1. A wire is soldered at V and led to the input binding post No. 2. This wire is kept quite close to the baseboard. Another wire is soldered at V^1 and led to the tube socket terminal marked G. The remainder of the wiring is left until the upright panel is assembled and fastened to the baseboard. Notes on soldering are given later.

The upright panel. (See A, Figures 1, 2 and 5.) The filament rheostat R^1 is mounted on the upright panel A so that the two terminals will be in a convenient position for wiring. Two binding posts of set-screw type, L and M, (Figures 1 and 5), are inserted in their proper holes, and the upright panel mounted in posi-

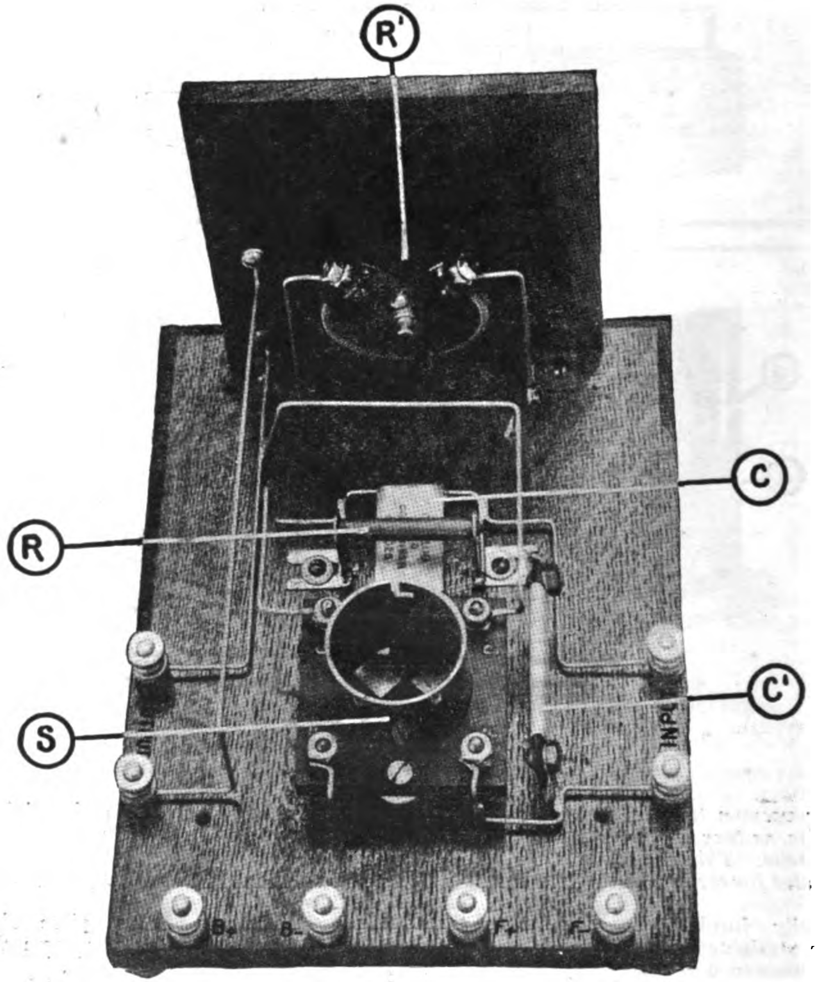

FIGURE 6

The completed instrument, ready to be connected to your tuner. Note the neat way in which the connecting wires are arranged.

tion by bolting it to the two brass angle pieces (Z and Z^1) shown in Figures 1, 2 and 6. One of the telephone receiver binding posts, L, serves as a bolt. Two small holes are drilled through the baseboard near the two terminals of the filament rheostat R^1. A wire is run from the "output" binding post marked 4 (Figure 1) along the upper side of the baseboard to the back of the telephone receiver binding post marked L. A wire is fastened to the tube socket binding post marked P and thence led to the back of the telephone receiver binding post marked L, or else soldered to a convenient place on the wire leading from binding post L. These wires are shown in Figure 1. A wire is run from the binding post marked 3 to the back of the telephone receiver binding post marked M and also a wire from B+ to binding post No. 3, underneath the baseboard. One of the terminals of the by-pass condenser C^1 is connected at the point X and the other terminal of the condenser is connected at the point X^1. The method of making these connections depends to some extent on the particular type of fixed condenser which is used. If the condenser be provided with flexible leads one of them is soldered at the point X and the other is likewise connected at the point X^1. If the condenser is provided with lugs, connections are made by bending the wires into the proper shape and soldering thereto. A wire is run from the filament rheostat binding post marked W through the hole in the baseboard and thence along the under-side of the baseboard to the binding post marked F. This wire is shown in Figure 1 by a dotted line. Likewise a wire is run from the rheostat binding post T and connected to the left-hand binding post marked F. This completes the assembling and wiring of the electron tube detector unit.

Directions for Operating

Connections. It has already been stated that better results are obtained if the two-circuit tuner described in POPULAR RADIO for July is used with the electron tube detector. However, the single-circuit tuner described in the May issue may be used or the electron tube detector may be connected to any tuner not already supplied with an electron tube detector.

If the single-circuit tuner is used with this electron tube detector, two more binding posts are added in the back right-hand corner and wired to the two rotating knobs on that set. Such wiring will not disturb the set for use as a crystal detector receiving set.

If the two-circuit tuner is used with this electron tube detector the arrangement of the parts is similar to that shown in Figures 4 and 5. Connections between the secondary of the coupler and the terminals of the variable condenser are the same as described in the July issue. Two more binding posts are added at the right-hand edge of the baseboard supporting the variable condenser and crystal detector. (See Figure 4.) The dotted lines clearly indicate the new wiring connections.

The antenna and ground wires are connected as described in the May issue. The two new binding posts placed on the old set are connected with the two binding posts marked 1 and 2 on the electron tube detector set, as shown in Figures 4 and 5. The telephone receivers are connected to the binding posts L and M as shown in Figure 5. The red (positive +) wire of the "B" battery is attached to the electron tube detector binding post marked B+ and the black (negative —) wire to the binding post marked B—. An insulated flexible copper wire is run from the red (positive +) terminal of the 6-volt "A" storage battery to binding post marked F+ (Figure 5) and a similar wire from the black (negative —) terminal of the "A" battery to the binding post marked F—.

Operation. The filament rheostat knob J (Figure 5), is turned to the extreme left and the electron tube E inserted in the electron tube socket S. The filament rheostat knob is then turned to the right until the electron tube filament becomes lighted, the brilliancy depending upon the type of electron tube used. When one of the telephone receiver terminals is removed from its binding post and again touched to the post, a sharp "click" in the telephone receivers will be an approximate indication that the circuit is in working condition. If the test buzzer as described in the May issue is available, it may be attached (as described) to the tuner binding post marked "ground" and then the rheostat adjusted until the sound in the telephone receivers is the loudest. The reader should bear in mind that the electron tube detector unit is merely substituted for the crystal detector and the tuning of the receiving circuit is the same as described in our May and July numbers. When signals from a desired transmitting station are heard as loud as possible by tuning, the intensity may sometimes be improved by adjusting the knob on the filament rheostat so as to increase or decrease the filament current (current from the "A" battery). The knob is kept in the position of minimum filament current without reducing the strength of the incoming signals.

If a detector type of electron tube be used, the voltage of the "B" battery is changed until the greatest signal intensity is obtained. This necessitates the use of a tapped "B" battery.

The operator must not expect too much of the apparatus at the first trial. Even assuming that he has had experience with crystal detectors, some difficulty may be experienced in getting the electron tube to operate. In this case he should first ascertain if the various parts of the complete receiving equipment are properly connected; or again, it may be found that some of the connections to the electron tube detector unit are improperly made. Special care should be taken to see that the "A" and "B" batteries are connected to the proper terminals of the electron tube detector unit. After a little experience the operator will find the electron tube to be much more positive in adjustment than the crystal detector.

Notes on Soldering

It has been stated above that certain connections were soldered. In fact, one could well advise that all connections about a radio circuit be soldered, but soldered correctly. There are some general hints that may be given, but judgment and experience are essential. The soldering copper must be clean and the tip well coated with solder. If the tip of the soldering copper is not bright, it should be filed clean. It is then heated, care being taken that the tip is not directly in the flame. After the copper is hot (but not red hot), it is dipped in the soldering flux or paste, and the copper tip coated with solder. The wires are cleaned where the soldering is to be done, using fine sandpaper; then a small amount of soldering flux or paste is applied at the joint and the wires to be soldered are tinned or coated with solder before they are joined. After the wires are tinned they are soldered together, using just enough solder to make the joint solid. The joint should not be jarred while the solder is still soft; to do so weakens the joint and gives the solder a dull appearance. A good soldered joint will be smooth and bright. All excess soldering flux or paste should be cleaned off. Gasoline or alcohol will assist in cleaning off the paste. This last point is sometimes overlooked and the excess flux often causes the copper wires to corrode.

The Approximate Cost of Parts

The list on page 170 includes the cost of parts of the electron tube detector unit and the "A" and "B" batteries. It does not include the cost of the telephone receivers or of any of the other equipment used to make up the complete receiving outfit, inasmuch as these details have been given in the May and July issues of POPULAR RADIO.

It is suggested that a pair of 2,000 or 3,000 ohm head phones of standard make be used in connection with the completed set.

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Will Radio Reform Our Politicians?

What Will Our Congressmen and Senators Say and How Will They Say It When Their Speeches Are Broadcast From the Capital and All the United States Can "Listen In"?

By HARRY A. MOUNT

AN austere member of the United States Senate objected because one of his colleagues used a naval radio station to broadcast a political speech. Government property, he says, should not be used for private political purposes.

This is all very well, argues the opposition, but so long as Congressmen enjoy the franking privilege, why not give them the freedom of the government radio stations?

"Under the law," says the New York *Herald*, "any Senator or Representative may use the mails without limit and without cost to himself for broadcasting speeches that have appeared in the Congressional Record. A Senator has burdened the mails with as many as a million copies of a speech. The letter carriers are annually bowed down with 20,000,000 copies of speeches. What may disturb Congress is not the use of Government radio but whether the party in power will grab the official radio for its own speeches in the important last weeks of a campaign."

One solution of this perplexing problem at once suggests itself: why not build a radio station atop the Capitol, assign it a wavelength and set it to broadcasting the whole proceedings of the Senate and House of Representatives? The venture might even be undertaken as an economy measure; it has its practical features. For instance:

Twenty million speeches, if each carried a two-cent stamp, would cost $400,000 in cash. If they were sent in franked envelopes the cost to Uncle Sam would not be considerably less. To this charge must be added the cost of printing and preparing for mailing. At least we may be sure that if the money now spent on franking were spent on maintaining a radio station at the Capitol, the results would be a thousand times more far-reaching and effective.

And that brings up another aspect of the influence of the radio on politics; if the proceedings of the United States Senate were broadcast by wireless, what effect would this method of publicity have on the deliberations of that august body?

If a Senator knew he were talking not just to a little group of partisans, each as intent as himself on playing politics "as she is played". . . .

If he knew he were addressing also more voters than there were at that moment in his whole district. . . .

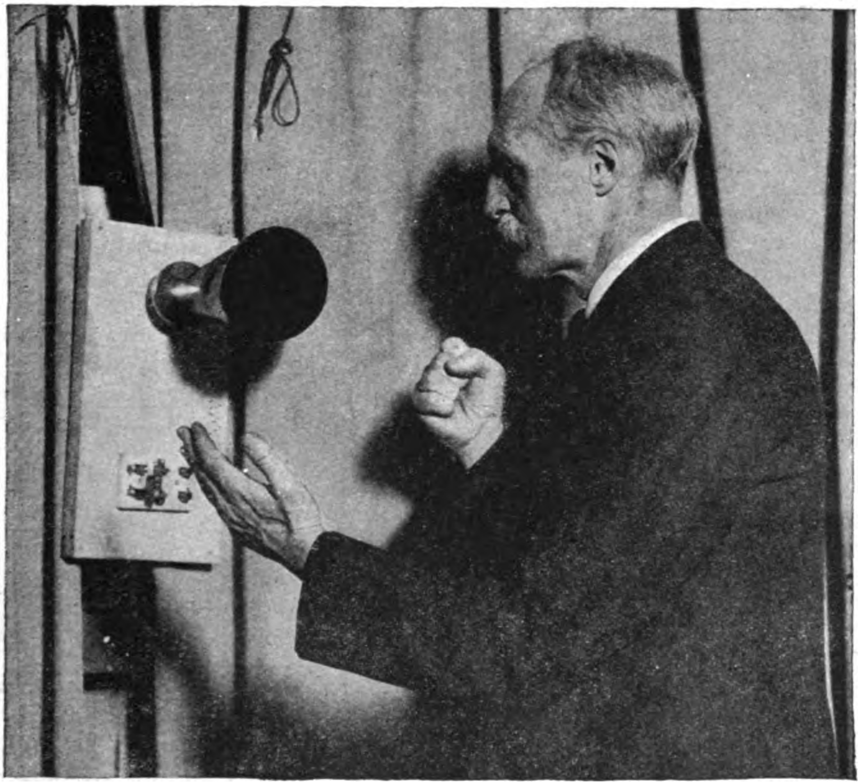
If he knew that enough men and women to turn the tide of the next election in his own district were listening to his every word. . . .

If he knew that more people in Ohio heard him than he could address personally if he made a lecture tour of that State. . . .

What would be the result?

Some day we may be able to "tune-in" on Congress, but whether or not that comes to pass, we are certainly going to have politics by radio from now on. And the effect, on the whole, may be gauged by what changes in the conduct of the Senate we might expect, if the whole Nation "listened in" on its deliberations. It will be interesting to watch the effect on politics of the radiophone.

Although the first widely popular use of the radiophone was in broadcasting the results of a political election—that was in 1920 when the East Pittsburgh



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COLD LOGIC WILL DRIVE OUT THE OLD-SCHOOL ORATORY

Gestures and platform tricks are lost on the radio audience. The political candidate—in this case Gifford Pinchot—must depend for his effects upon sound argument and authoritative data.

Station KDKA was used for this purpose—only limited political use has been made of radio since.

In October, 1921, in Pittsburgh, when the offices of mayor, coroner, sheriff and other local officials were open, the radiophone played a very important part. Every candidate, regardless of party, was given an equal opportunity to speak from KDKA. Most of them took advantage of the opportunity. The experiment was so successful that in the last senatorial and gubernatorial elections in Pennsylvania this same station broadcast speeches by all of the leading aspirants.

In both cases the time allotted each candidate was equal, and it was understood that the speeches would be an announcement of opportunities and promises to constituents as to service if the candidate speaking were elected. It is fortunate, in this case, that the station is controlled by a disinterested party. Equal opportunities might not have been afforded by a station controlled by a newspaper or a political organization.

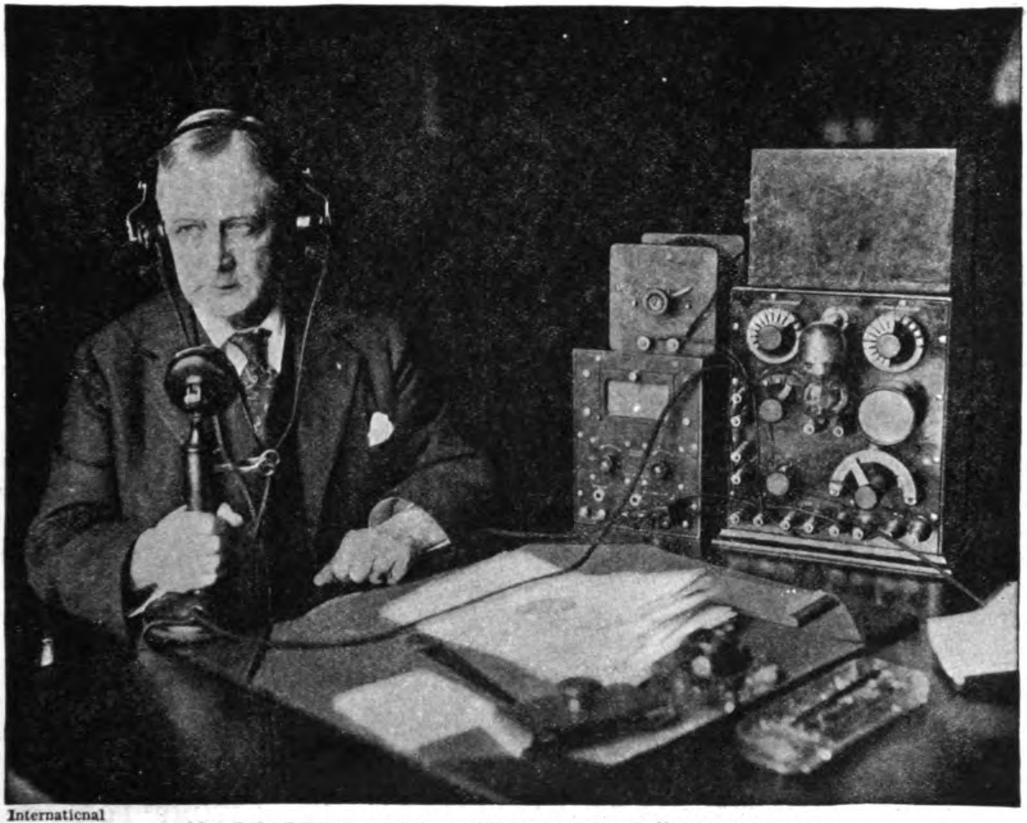
A somewhat more limited use of radio was made in New York in the 1921 municipal campaign when Mayor Hylan and some others of the candidates spoke from one of the local broadcasting stations. But the event had not been widely announced and only those wireless enthusiasts who happened to "pick up" the speech heard it.

The first real test of the value of radio in politics will come, no doubt, in the presidential campaign of 1924. No one can predict with certainty just what will happen, but no doubt the leading candidates will make wide use of the radiophone. Many of our political leaders al-

Pacific & Atlantic

THERE WILL BE NO ALIBI FOR THE CAMPAIGNER-BY-RADIO

Promises made will be heard by voters generally—not by special groups whose favor is courted. Newspaper reporters cannot be charged with "misquoting" a candidate. This picture shows Representative Alice Robertson of Oklahoma addressing her constituents.



International

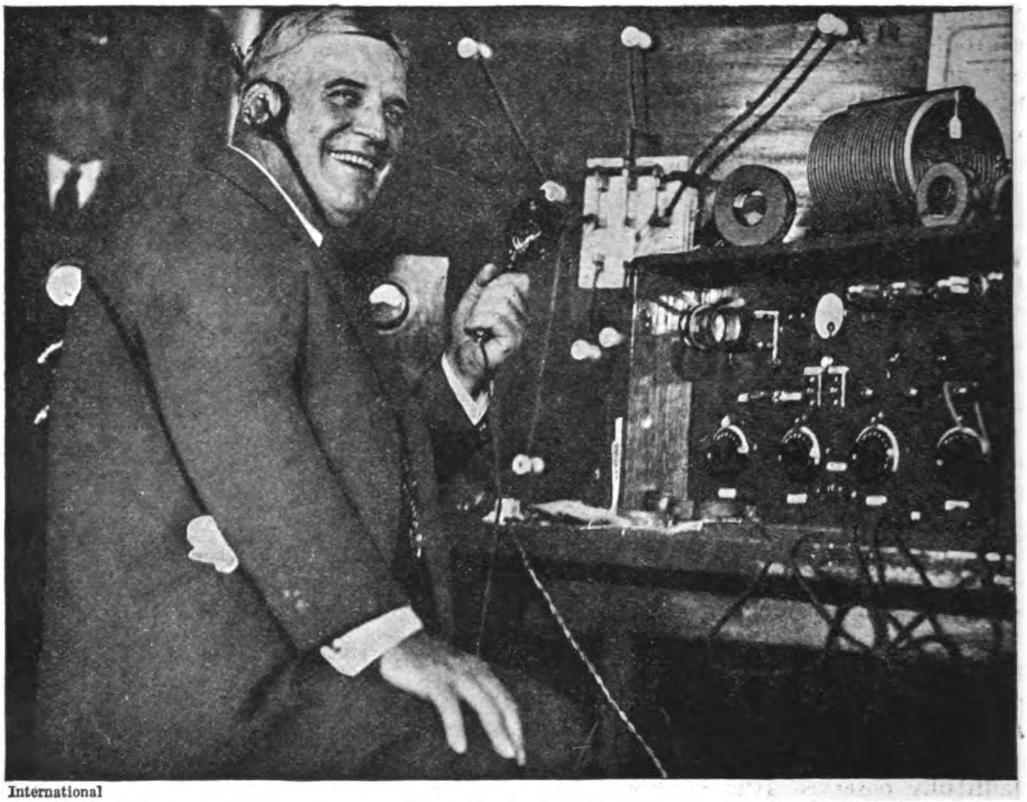
HE STARTED SOMETHING WHEN HE SPOKE OVER THIS RADIOPHONE

When Senator New spoke to his constituents in Indiana last spring by means of the Anacostia radio station maintained by the Navy he opened up the question as to whether or not government radio stations should be used for political purposes, and if so, under what conditions.

ready have made short addresses by radio and they are fully alive to its possibilities. The list of notables who have talked from a single great broadcasting station include President Harding, Secretary of Commerce Hoover, Secretary of Labor Davis, Secretary of War Weeks, William Jennings Bryan, Theodore Roosevelt, Jr., Governor Sproul of Pennsylvania, Governor Allen of Kansas, and Mayor Key of Atlanta.

At this writing a conservative estimate places the number of wireless receiving stations at 800,000. Last spring equipment was sold just as fast as it could be manufactured. In fact the demand from the larger cities could not be met and little had been done toward introducing radio into the rural districts. Careful investigation has shown that for every receiving station there are four or more head phones so that the whole family may listen in. The present radio audience may therefore number between 2,000,000 and 3,000,000 persons. Further estimates place the possible radio audience of 1924 at not less than 20,000,000.

There has never been a means heretofore, in spite of all the wonders of the telephone and telegraph and the great modern press system, whereby so many persons could be reached so cheaply, so easily, and so directly. Politicians are not going to overlook that fact. They will make the fullest possible use of radio in future elections.



International

THE "SPELLBINDER" OF TODAY IS FORSAKING "THE STUMP" FOR THE TRANSMITTER

For one reason because he can vastly extend the range of his influence; instead of reaching merely hundreds he can reach tens of thousands—as Governor Sproul of Pennsylvania (pictured above) has discovered.

And that brings up the question of what the fullest possible use will be.

It is obvious that if each party or faction sets up its own radio and begins broadcasting its particular brand of propaganda there will be a great deal of confusion from which no great profit may be expected. So long as a man's audience was limited to the number of persons who could get within hearing distance of him the principle of the freedom of speech could be applied in its broadest possible meaning. While he could find someone to listen to him, he could talk as long and as loud and as much as he liked. But when the size of an audience increases until a speaker may have more hearers than there are people in the cities of New York, Philadelphia, Chicago and San Francisco combined, and as only one man at a time can address that audience effecively, it is evident that some sort of an agreement will have to be reached between the various groups.

It would seem an ideal situation if control of the great broadcasting stations should remain in the hands of disinterested parties, and if the government-owned radio should be continued chiefly for the purpose of broadcasting such serviceable information as time and weather reports, market reports, storm warnings, and the like. Likewise, it would seem something of a calamity to this great radio audience, as well as to the politicians themselves, if each party attempts to broadcast its own propaganda, or if any party attempts to monopolize any one of the great broadcasting agencies. This is a problem which no doubt will adjust itself in time, but, no matter what final solution is reached, the effect upon political methods is bound to be far-reaching.

Consider, for instance, the matter of election promises. It has always been a temptation to political speakers to temper their promises according to the audience they are addressing. If they happened to be talking to an audience of union laboring men they were quite likely to extol the dignity of labor and the strength of union, and to promise that if elected union labor would have a sympathetic friend in office. If, on the other hand, the audience happened to be composed of the members of a country club, the address very likely would take quite a different tone. But if the same speaker were to address a vast invisible radio audience of hundreds of thousands or millions of persons from every walk of life (with no chance to claim the reporters had misquoted him), any promises made would probably be carefully considered and faithfully observed after election.

And not only would the substance of his address be changed, but his very manner of speaking probably would have to change to meet the mechanical conditions of radio transmission.

It has been found by repeated experience that highflown oratory is not effective by radio. Much better transmission qualities are obtained by speaking in a quiet, evenly modulated voice. Extemporaneous talks have proven equally disastrous. Speakers have found it very hard to address extemporaneously an audience which they cannot see and which cannot see them. There are pauses which become very painful and embarrassing. For this reason most radio speakers now read carefully prepared papers, conscious that they must impress their hearers by the thought they present, rather than by any oratorical effects or by the charm of personality. It seems quite plausible, then, that as radio becomes more widely used and more effective in campaigning, we may see the ascendency of quite a new type of politician—a hard thinker who knows his subject thoroughly and speaks with quiet authority, as opposed to the bombastic type of present-day politician.

Presidential candidates will find themselves addressing large numbers, too, of a class of voters whom they have had to neglect in the past. These are the small town and country dwellers who are going to relieve the loneliness of isolated existence by snatching out of the ether, with equal facility with their city brothers and sisters, the very voices and personalities of the great.

Many of those who have given thought to the future usefulness of the wireless believe it will find its chief usefulness in the thousands of homes far from the great centers of population to which the affairs of government, the art and the music of the big cities, the marts of trade, are now rather vague and distant realities. It is true that only a few aerials are at work now over the homes of country dwellers, but no vivid imagination is required to foresee the day, and that soon, when every farm house will have its wireless receiving station. The farmers—especially those who live in distant and out-of-the-way places—are going to be brought into closer communion with state, national and world affairs through the radiophone.

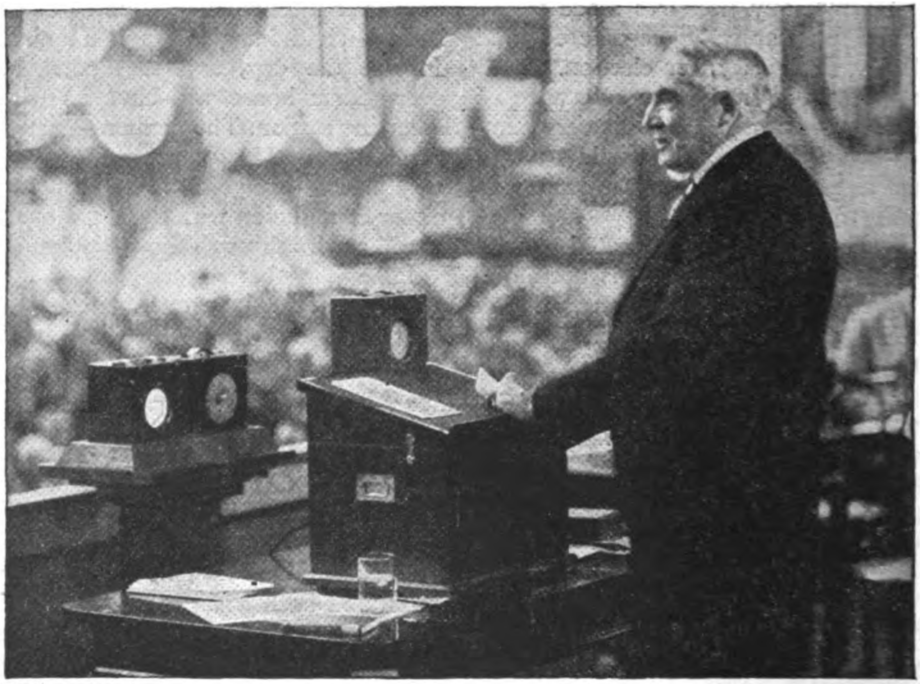
It has long been a criticism of the republican form of government that so many citizens fail to record their judgment by voting, ofttimes making it possible for a well-organized minority to carry an election. No doubt the wireless phone will help to correct that condition. An intelligent interest in government will be stimulated through lectures by competent authorities. As a matter of fact, one of the broadcasting stations has already inaugurated such a series. Before an important election there will be, no doubt, speakers who will emphasize the importance of voting and who will give instructions as to how to cast a ballot.

Students of politics agree that this government of ours is still in the experimental stage. So far the experiment has been so successful that it appears the whole world is taking us for a model.

There have been popular governments before this; but always they have grown to a point where the will of great bodies of people was hard to record, or being recorded, was misinterpreted, or again deliberately perverted by those in power. Ancient Greece had a form of popular government but it became a dictatorship of the cities because only in the cities was it possible to get enough people together to reach a popular decision. Rome also began her greatness with a popular form of government, but the actual number of people who had a voice in her government was limited to those who could crowd into the Forum. Even most of these heard imperfectly what the orators told them and understood even less; hence it was easy for politicians to sway their decisions by conventional and studied dramatic inflection and gesticulation.

The modern system of communication and the newspapers have remedied to a great extent these weaknesses. We have lately seen some startling demonstrations of the power of public opinion to guide the agencies of government. But our popular government is on a grander scale than has ever before been attempted. The number of voters has only lately been doubled by the enfranchisement of women. We need, more than ever before, the enlightening influence of such an agency of publicity as the radiophone promises to be.

The radio will tend to purify politics because it will bring the public into closer contact with its political leaders, and will tend to eliminate those superficial qualities of the old-time spellbinder for the obvious reason that those qualities will not carry over the radio—whereas his facts and his logic and his promises will.



Pacific & Atlantic

WILL RADIO SOUND THE KNELL OF "SECRET SESSIONS"?

When President Harding recently addressed the Chamber of Commerce in Washington his voice was broadcast throughout the East. Some day the deliberations of Congress—and perhaps of the Cabinet—will be heard by millions.

TRICKS—

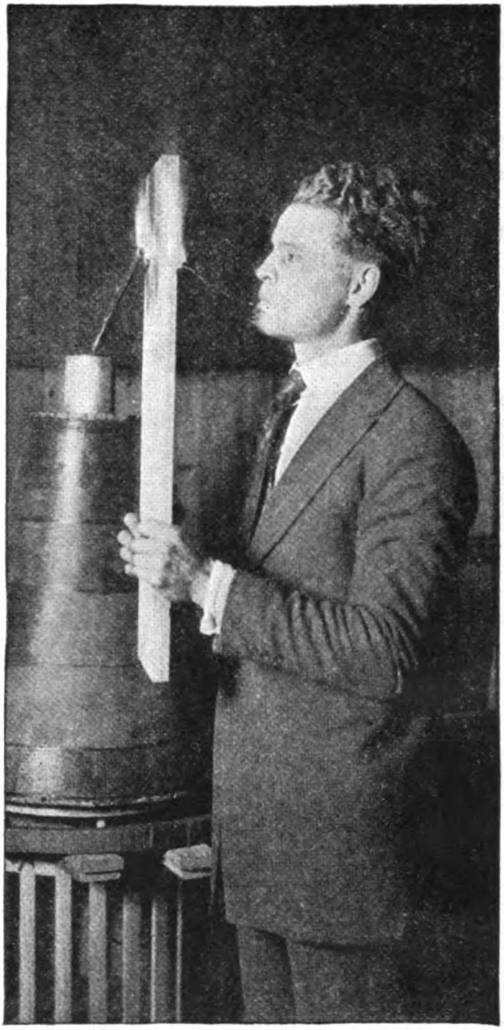
With High Frequency Electric Current

How the Amateur May Give Spectacular but Harmless Demonstrations of the Peculiar Qualities of that Form of Electricity that Is Used in Radio

By
LEONARD R. CROW

TO the layman, demonstrations of high-frequency electric currents, such as are employed in radio, have an interest that is not lessened by the element of apparent danger with which they are attended. Some of these experiments are spectacular; to a peculiar degree they combine entertainment with instruction. The fact that many of these demonstrations can be easily staged as "tricks" give them an added value to the repertoire of both the amateur and professional entertainer.

Most of our readers will understand what is meant by an alternating current of electricity—a current which changes its direction of flow a certain number of times a second. Commercial currents, which light our homes, run our small power motors and revolve our electric fans, may change their direction of flow between one hundred and two hundred times a second. In such cases the frequency or cycles a second are one-half the number of alternations, as a cycle consists of two alternations.



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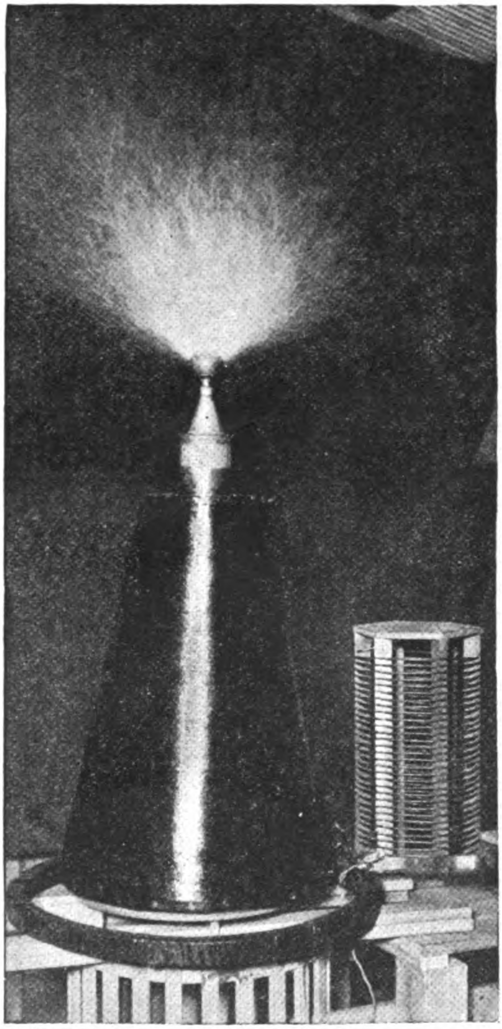
"SWALLOWING" 80,000 VOLTS

This voltage—which punctures a solid oak board an inch thick and sets it on fire—can be taken through the human body without discomfort—provided the frequency ranges above 30,000 cycles a second.

Such currents of low frequency possess certain characteristics which make them dangerous to the human body at pressures of 200 or 300 volts; in many cases lower potentials have produced disastrous results. The low potential, low frequency currents are dangerous when only a small fraction of an ampere is forced through the body, causing contraction of the muscles and a "shock" which is often fatal.

However, if we take this low frequency current—for instance, 60 cycles—with its dangerous and destructive characteristics, and by the use of certain apparatus increase its frequency, or number of alternations a second, until the frequency is raised many thousands of cycles a second, we change the characteristics of such a current completely. The current then ceases to be painful or dangerous when passed through the human body; and by increasing the potential it can be made to jump across a gap several feet in length, producing a crashing violet flame almost as harmless as the foods we eat. When such currents pass through our bodies we no longer experience shocks, but instead a pleasing sensation of mild warmth is produced, which has been said to have a beneficial effect upon the body.



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A THREATENING DISPLAY OF FIRE

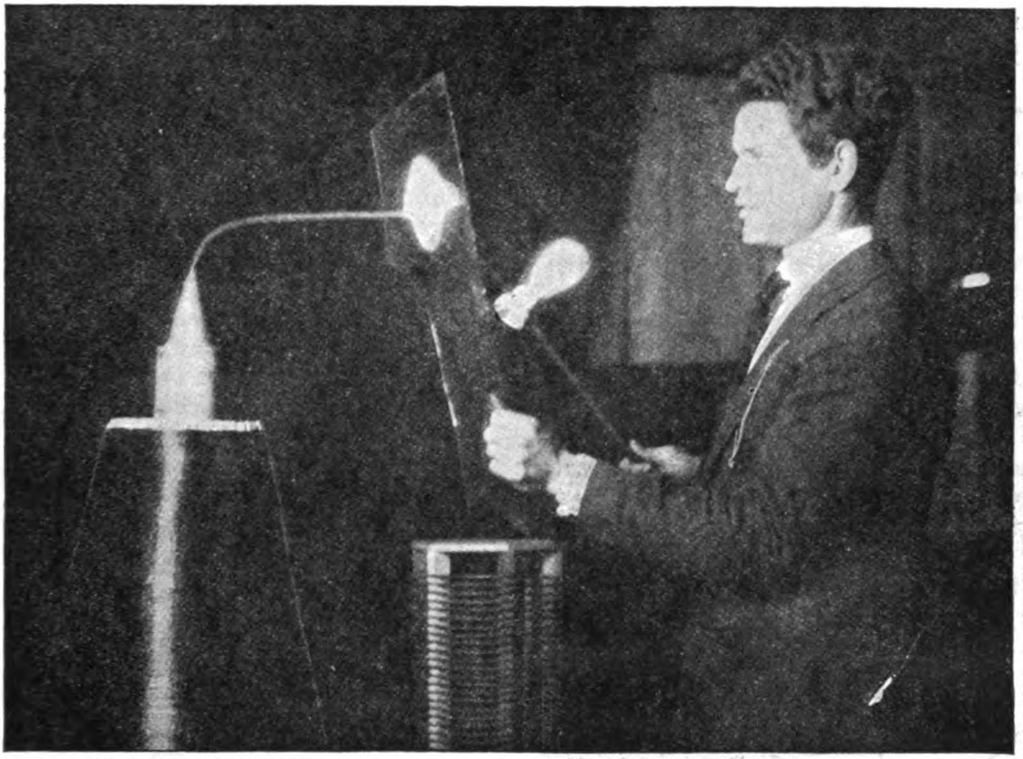
This snarling and snapping bundle of violet-colored sparks is entirely harmless, however; it is caused merely by discharging into the air a high frequency, high potential current.

When such a current of electrical energy is allowed to discharge through or into the air, the discharges assume the shape of hundreds of snarling, writhing, hissing flames of fire. But threatening as these flames appear, they are not dangerous to the body, as one would suppose. In the apparatus shown on this page, for example, I employed 1,800 watts of electricity. This same electric power at commercial frequencies would not begin to produce a spectacular display, but it would be thousands of times more dangerous to the human body.

If a coil consisting of five or six turns of heavy wire or ribbon is suspended in the air several inches above a high frequency electrical current of even moderately high potential, a current is induced in this secondary coil sufficient in voltage and amperage to light a 110-volt lamp, as shown in the picture on page 188.

With electricity at high pressures and at high frequencies, electrical energies may be passed into the human body sufficient in intensity and strength to produce arcs that give great light and heat. When this oscillating energy is transmitted into the body, passing through a plate of glass in which a 60-watt standard 110-volt lamp is lighted to incandescence, it appears to the eye that these currents actually pass through the glass. However, the current does not pass through the glass as an electric current, but rather in the form of electrostatic charges; the glass, after passing this heavy current, does not exhibit any physical change in the condition of its surface.

One of the most interesting features of this phenomenon is that the physiological effects of even extremely high frequency, high potential currents are found to be so very small that the current from a secondary terminal of the



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"MAKING AND MENDING" HOLES IN GLASS WITH CURRENT

The electricity transmitted into the body through a glass plate (lighting an incandescent globe on the other side) appears to pierce the glass. Actually, however, it passes in the form of electrostatic energy and leaves no mark whatever on the plate.

oscillation transformer can be taken through the body without any discomfort or inconvenience to the recipient (except perhaps a small burn produced by the discharge when taken directly upon the bare skin).

One should never attempt to take large currents directly into or upon the body without first receiving the current through some form of metal electrode. For instance, when one takes currents into the hand, the current should be taken from the machine through a metal rod which is held in the palm of the hand. In this manner a large contact area is offered to the flow of current, and thus, distributing the received currents over a large area, reduces the piercing or burning sensation to a minimum.

In taking currents into the mouth a common tablespoon may be used to advantage, as this affords a good contact with the tongue.

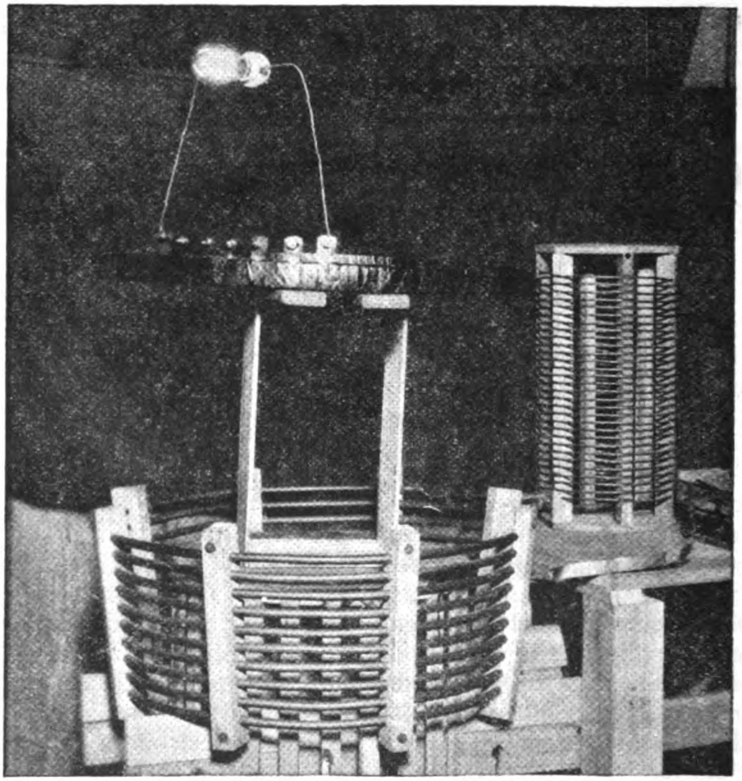
The peculiar effects of these currents may be due to several reasons—either to a different distribution through the body or to the tissues acting as condensers; although in the case of large high frequency coils that carry larger amounts of energy, the harmlessness would indicate that the cause might be due to other conditions not yet determined. One theory is that our nerves, fast as they are, are still too slow to respond to currents so rapidly oscillating. If the current that passes through the body in one direction affects the nerves, the current as it reverses, neutralizes the effect of the first half cycle before the nerve had time to respond. Another theory is that high frequency currents pass only on the outer surface of a conductor, never penetrating the body far enough to affect the nerves.

When the frequency and strength of currents flowing through the primary of a high frequency coil are varied, many different forms of secondary discharges are produced—thin, threadlike discharges, powerful, flaming discharges, and various forms of brush and streaming discharges. A high frequency current discharge, when properly produced, gives the appearance of a purple flame of burning gas under great pressure, emitting quantities of ozone.

The striking peculiarity of high frequency discharges, brushes and streamers, is the ease with which they pass through thick insulation.

However, this current is not confined to the use of spectacular and mystifying phenomena. Such high frequency, high potential currents, when properly applied to the body, are said to improve general nutrition and act as a tonic in building up the body; curing many diseases by stimulating the circulation.

Through the production of high frequency electricity we are capable of seeing the otherwise invisible. The X-ray, one of the greatest discoveries of man, is possible through the use of high frequency waves. Today man is capable of transmitting his very thoughts across great distances with incredible speed and accuracy without the aid of any visible transmitting medium. Were it not for this mysterious rapidly vibrating radio frequency electricity, wireless telegraphy and telephony would still be a thing unknown.



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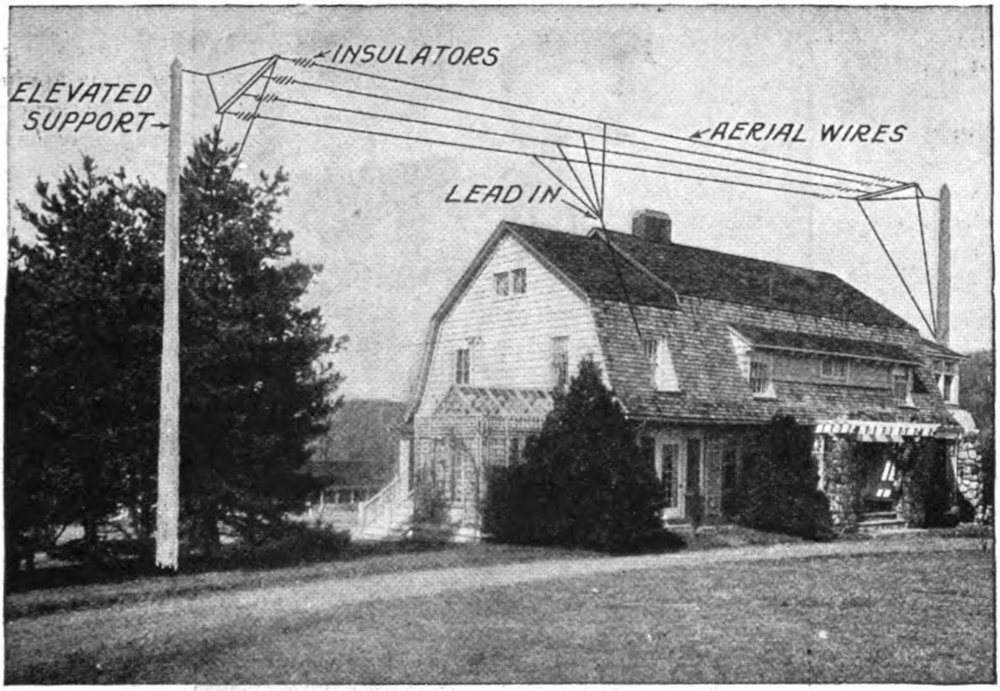
LIGHTING AN INCANDESCENT LAMP "WITHOUT A CONNECTION"

The energy for lighting the standard 110-volt globe is sent through the air. This current is induced in a coil consisting of five or six turns of copper wire suspended above a primary coil in which high frequency current is flowing.



From a diagram made for POPULAR RADIO

The Most Popular Transmitting Aerial

THE T-TYPE OF ANTENNA

The Second of a Series of Short Articles on the Various Types of Antennae and Their Uses

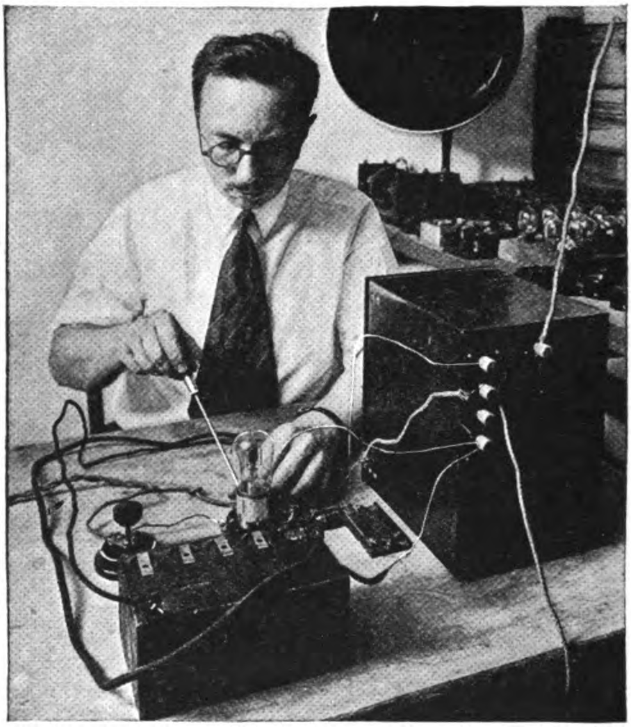
By DAVID LAY

THE inductance of an antenna depends, roughly, on the total of the length of the ground lead and the length of wire from the set to the farthest tip of the antenna. In the case of the inverted L type of antenna this would include the length of the ground lead, the length of the lead-in, and the length of the flat top. This would give a certain wavelength which would correspond to the "natural period" of the antenna.

Suppose, for example, that we should be so located that we could not put up the ordinary 100-foot antenna as used for broadcasting reception, but could put up a longer one, say 150 or 200 feet long. Ordinarily the wavelength or natural period of this antenna would be too high.

If we put up a T antenna of this extra length, (that is, if we should divide the flat top in two, with the lead-in in the center as shown in the diagram on this page), we will have the same over-all length from the ground to the farthest tip of the antenna as in the shorter L type of antenna. This will give us an antenna with approximately the same inductance but twice the capacity. Obviously this antenna would have a lower wavelength than an L type antenna of the same length and would be ideal for transmitting, while at the same time it would be suitable for receiving.

The T type antenna will provide slightly better reception characteristics in the directions in which the two ends of the antenna point, but it will receive well from any direction.



From a photograph made for POPULAR RADIO

THE AUTHOR SHOWS HOW TO DO IT

In order to insure accuracy in his description of the way to tune a standard single-circuit regenerative receiver, Mr. Hogan actually performed the work in his laboratory—as these illustrations demonstrate. He especially warns the amateur against allowing the tube to oscillate, which causes interference to others in the neighborhood.

The Right and Wrong Ways *of* Adjusting *the* Regenerative Receiver

By JOHN V. L. HOGAN

ALTHOUGH it is not at all difficult to handle a simple regenerative receiver so as to secure from it really remarkable gains in radio reception, there exists a widespread impression that great skill is necessary for its proper manipulation. This is perhaps due to two prime causes:

First, because many poorly designed regenerators, which are almost impossible to control properly, have been made or sold and are in use;

Second, because well planned and built receivers are frequently supplied with incomplete or even misleading instructions for operation and so puzzle unskilled users.

Radio phenomena, understandable enough when the fundamental reasoning underlying them is explained, are indeed baffling to the uninstructed novice; when one adds to the simple tuning effects the interesting and varied actions which the feed-back circuits produce, it is something of a wonder that in the tremendous recent growth of radio receiving more trouble has not been experienced.

In order to fix our ideas about the

operation of the Armstrong feed-back, let us concentrate upon a simple circuit arrangement which is now in wide use and which is capable of giving excellent results with only simple adjustments.

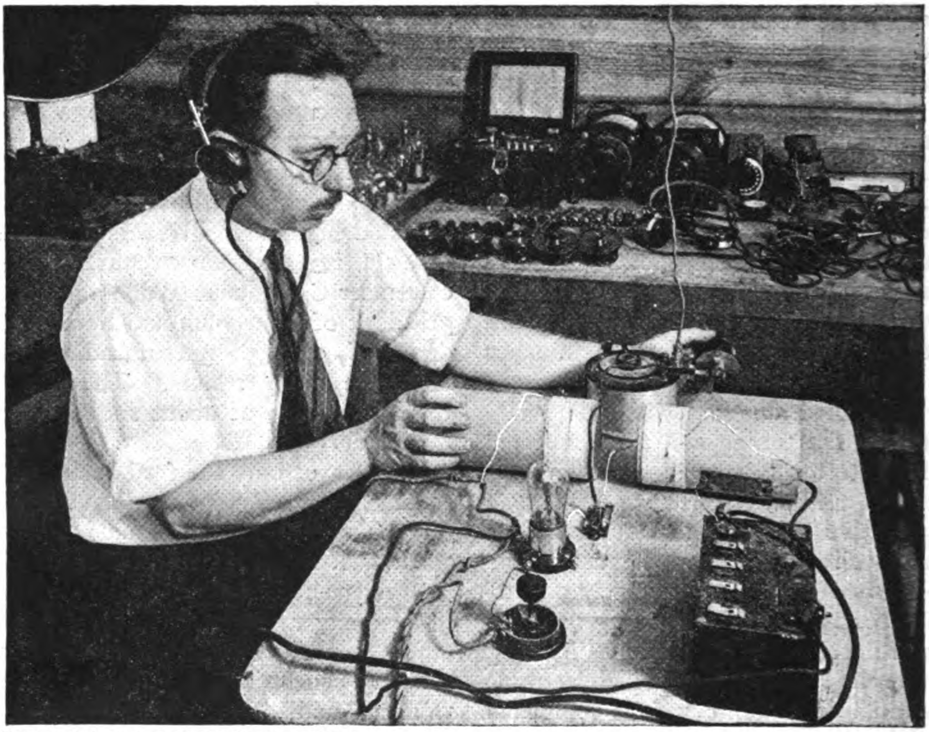
Figure 1 is a diagrammatic representation of this layout, which may be called the "single-tuned circuit" with inductive feed-back. It shows a simple aerial-to-ground circuit including a variable tuning condenser and a tuning coil which is preferably adjustable in steps and to which is inductively (and variably) coupled another coil. The terminals of the tuning coil are connected to the detector tube grid, through condenser C_1 and leak resistance R_1, and to the negative side of the filament. The filament circuit includes the usual six-volt storage battery and a finely adjustable rheostat R_2 for controlling the temperature or brilliancy of the filament cathode and consequently its electronic emission. The plate circuit is completed through the second or feed-back coil above mentioned (frequently called the "tickler" coil), the telephone receivers and the "B" battery of about 20 volts potential—the telephones being shunted by a by-pass condenser C_2.

For best results on the 360 meter wave length, which is common in radio broadcasting, the aerial capacitance should be not greater than about 0.0005 microfarad, and its natural wavelength less than 220 meters or so. These conditions will be met by a single wire antenna from 120 to 150 feet long (including the down-lead to the instruments) and from 40 to 60 feet above the earth. The tuning condenser should be variable over at least the range from about 0.0001 microfarad minimum to 0.0007 maximum capacitance. The tuning coil should have an inductance in the general neighborhood of 50 to 100 microhenries, the exact value (which may in some cases be outside these limits) being determined largely by the particular antenna used. A coil of fifty turns of No. 22 B & S double cotton-covered magnet wire wound on a cylinder of 3½ inches diameter and provided with taps at 20, 30, 40 and 45 turns will give good results in most cases. A "hard" vacuum tube like the VT-1 or UV-201 should be used for the detector, as its vastly increased stability is ordinarily to be preferred over the delicately adjusted higher sensitiveness of a gassy tube in regenerative circuits. A grid condenser C_1 of about 0.0003 microfarad, grid leak of 1 megohm and by-pass condenser C_2 of 0.005 microfarad will usually give good results. The filament rheostat will be of about six ohms total resistance.

This leaves only the feed-back coil for consideration; a winding identical with that suggested for the tuning coil will work well under most conditions. The two coils should of course be arranged to be easily moved with respect to each other, so that the amount of feed-back coupling can be varied conveniently. In working with wavelengths as short as 360 meters and capacitance values of the order of 0.0005 microfarad and less, changes in tuning are frequently produced by the additional capacitance introduced when one's hand is brought near the circuit to adjust it. In an experimental outfit these bothersome effects can be avoided by fitting the tuning condenser and the coupling with insulating control handles some twelve inches in length, which will permit adjustment without close approach of the operator's hand. When a set is built up in panel form, a grounded copper shield plate between the control knobs and the instruments aids in securing compactness.

So much for the constructional fundamentals of a simple but effective regenerator.

It will be noted that there are only four variable elements in the entire system, namely; (1) the tuning condenser; (2) the tuning coil; (3) the coupling controlling the amount of feed-back, and (4) the filament rheostat. As the last-named item is not critical and as both the tuning controls produce the same



From a photograph made for POPULAR RADIO

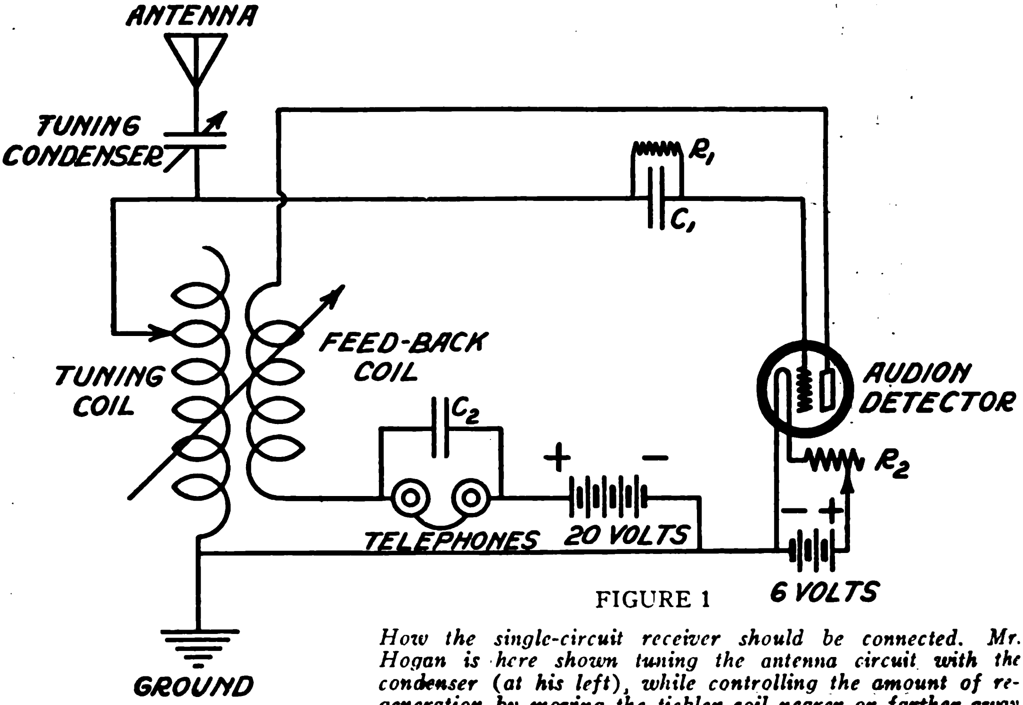


FIGURE 1

How the single-circuit receiver should be connected. Mr. Hogan is here shown tuning the antenna circuit with the condenser (at his left), while controlling the amount of regeneration by moving the tickler coil nearer or farther away from the tuning coil.

general effect, it is fair to say that only two elements (the tuning condenser and the feed-back coupling) need be adjusted in the normal use of this outfit. The tuning condenser will ordinarily be of the semi-circular multiple plate type having a total capacitance of about 0.001 microfarad; for easy adjustment in short wave working it is convenient to provide in addition a so-called "vernier" condenser, which has only two or three plates and which, when connected in parallel to the main tuning condenser, produces a change of tuned wavelength (for a motion through its entire scale of 180°) equivalent to only three or four degrees of the main condenser. The other adjustment—the feed-back coupling—may be controlled by turning a knob which varies the angular position of the "tickler" coil with respect to the tuning coil, or simply by moving the coils themselves nearer together or farther apart.

If you have purchased a regenerative receiver of the single circuit inductive feed-back type you will have no difficulty in these two adjustments; the handle usually marked "tickler" controls, from maximum to minimum, the amount of regeneration; and the resonant wavelength is varied by means of the "tuner" knob, supplemented, in some of the better instruments, by a closely adjustable condenser called the "vernier," as described above. In setting up an assembled or home-made outfit, however, it is necessary to determine the proper or additive direction of feed-back coupling. To do this, first be sure that the circuit is wired exactly as shown in Figure 1; put into circuit the full 50 turns of each of the two coils, and place them some distance (at least 8 to 12 inches) apart on the operating table. Listening in the telephones, test the detector circuits by turning on the filament to normal brilliancy and making and breaking a connection of the 20-volt plate battery; if everything is all right a strong click will be heard in the telephones at each completion and interruption of the circuit. By varying the tuning condenser it should now be possible to pick up (and tune to maximum strength) some radio telegraph or telephone signals; perhaps it will be necessary, if your aerial is relatively large, to reduce the number of turns used in the tuning coil. If signals can be "tuned in," the proper current direction in the feed-back coil can easily be determined by moving it nearer to the tuning coil, for if the signals increase in strength as the coils approach each other everything is all right. On the other hand, if bringing the two coils nearer together produces a weakening of the signals, either the tuning coil or the tickler coil must be reversed end for end. Once having the relative directions correct, the amount of regeneration is, of course, controllable from minimum to maximum by moving the coils from a relatively widely spaced to a closely adjacent position.

If signals cannot be picked up while the coils are far apart, try varying the tuning condenser as the coupling between the coils is increased, first with one relative direction and then with the other. Radiophone or wireless telegraph messages may be intercepted at some wavelength, with the help of regenerative amplification, so that the proper relation of the coils may be observed. If no signals whatever can be heard at the time the apparatus is being tried out, you will have to rely upon the oscillation test. Listening in the telephones as before, slowly bring the tickler coil near to the tuning coil; as they approach, if the relative directions are correct, you will hear a single "cluck" in the telephones. This marks the point of increased regeneration at which the whole receiver begins to generate radio-frequency oscillations. On moving the coils apart these local oscillations will cease; by increasing the coupling once more a repetition of the "cluck" will be heard, indicating the recommencement of oscillations. If the two coils are wrongly directed with

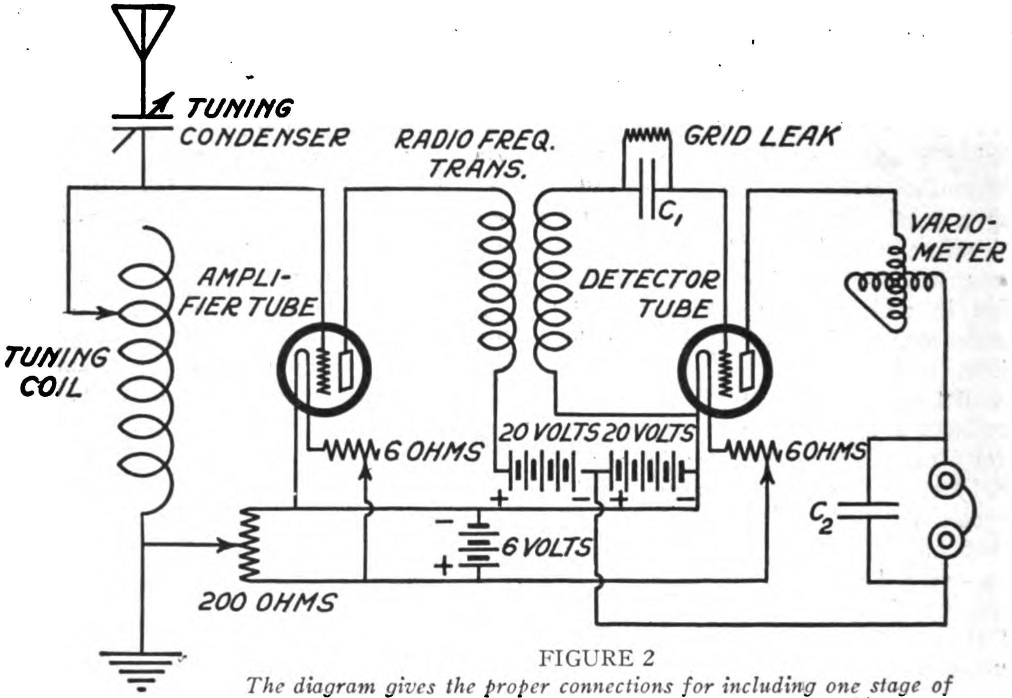


FIGURE 2

The diagram gives the proper connections for including one stage of radio frequency amplification in the regenerative set. By this means the set is prevented from re-radiating high frequency oscillations, which cause so much interference in the hands of inexperienced operators. Static is also reduced by this addition.

respect to each other it will be found either that these oscillations cannot be produced at all or that the two coils must be nearly touching each other in order to do so. The remedy is, as before, to reverse one of the coils. Instead of turning one coil end for end, the wires connecting to it may be transposed.

Now let us look a little more closely at the adjustments necessary to get best results.

The set must be so assembled that the oscillation or "cluck" effect just described can be secured easily at the working wavelengths; when the feed-back coupling is increased to the point where oscillations are generated, their presence can be detected by tapping the grid connection of the detector tube; on each contact of the finger this same characteristic cluck will be heard in the telephones. If your set will not work in this way it is not regenerating properly, and you will not get the best results from it until it is fixed up.

To pick up a signal of unknown wavelength, or one for which the tuning condenser setting is not known, the tickler coupling should be set at a point sufficiently loose (toward the minimum) to prevent the set from oscillating as the condenser knob is swung back and forth throughout its range. If the desired signals are not heard at any point of the condenser scale with the full tuning coil inductance in circuit, change the number of turns and swing the condenser handle again; when the tuning coil is reduced in inductance by cutting out some of its turns, the tickler coil can ordinarily be moved up closer to the tuning coil without causing oscillations to begin.

After you have found the best number of tuning coil turns and the best condenser position for the desired signals, move the tickler coil slowly toward the maximum coupling position; as the coupling is increased nearer and nearer to the point where the receiver starts to generate oscillations, the signals will grow louder and louder. The tuning condenser should be readjusted slightly as the tickler coupling is increased, for the greater feed-back action makes the circuit more sharply tuned and a very exact setting becomes necessary in order to secure the loudest signals. It is for this final critical adjustment that the vernier condenser is so convenient.

The feed-back coupling cannot be increased indefinitely, for as the point where oscillations begin is closely approached the signals will not only increase in volume, but will show signs of distortion. This is particularly disadvantageous in receiving radiophone speech or music with amplifiers. When the oscillation point is reached or passed, the radio-frequency currents generated in the receiver react with those of the received wave to produce electrical beats which may entirely spoil the character and quality of the signals; hence the feed-back coupling should always remain on the side toward "minimum" from the oscillating point, for receiving radiophone, spark or other modulated wave signals.

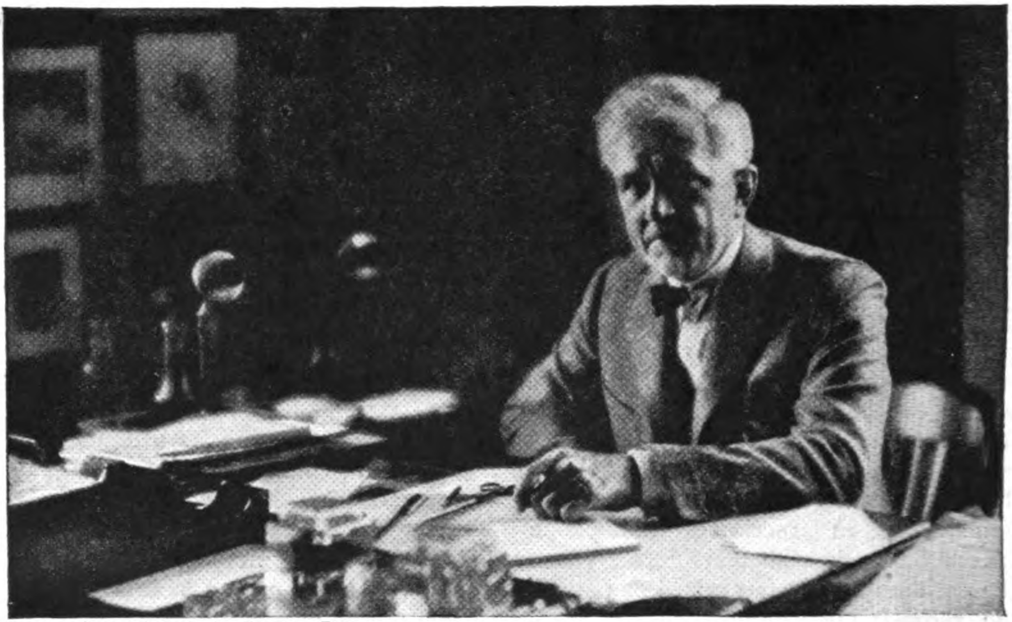
There is another good reason, beyond the loss of signal clarity, for always keeping the tickler coupling below the oscillation-generating point; the radio-frequency currents set up in the receiving outfit by circuit reaction pass out of the receiver itself and into the aerial, there radiating electromagnetic waves of the frequency to which the set is tuned. Thus the receiver virtually becomes a continuous-wave transmitting outfit, which, although relatively feeble in power, is capable of creating severe interference for several miles around.

Every time you allow your regenerative receiver to break into the oscillating condition by increasing your tickler coupling too far, you send out radio waves from your antenna. Every time you hear in your telephones the loud heterodyne whistle caused by interaction between the received carrier-wave and the oscillations generated within your outfit, the waves your set radiates are producing similar interference whistles in sensitive receivers near you. Thus you not only spoil your own reception, but also that of your radio neighbors in a zone of several square miles. All of us have heard interference produced in this way and have learned how aggravating it is. As this disturbance is totally unnecessary and nothing more than a demonstration of ignorance or lack of consideration on the part of "transmitting" receiving set users, no one who understands its causes and effects will want to create such interference deliberately.

While there is no hardship in tuning to an unknown telephone or modulated wave while keeping the regenerative receiver slightly below the just-oscillating condition instead of slightly beyond it, sometimes one finds it convenient to pick up a continuous wave by setting the receiver into oscillation and swinging the condenser knob back and forth until the heterodyne whistle is heard. This should never be done at wavelengths near the broadcasting wave of 360 meters; even at other frequencies it may produce bad interference. However, by equipping the receiver with a single radio-frequency amplifier in advance of the detector tube, the local oscillations may be kept almost entirely out of the aerial and this source of interference practically eliminated. Figure 2 shows a circuit arrangement of this kind; further details of it will be given in a future article.

How to Select the Best Coil for Your Set

In the next number—December—Prof. J. H. Morecroft will tell the radio amateur just what the functions of a coil are and how to determine which coil is best suited for the amateur's purpose.



From a photograph made for POPULAR RADIO

"THE AUTHOR WHO ENTERTAINS BY RADIO SHOULD BE PAID"

The problem of collecting fees for the use of copyrighted music that is used on broadcast programs has long been agitating the music publishers. Now the book publishers are wondering how the rights of the literary man can be similarly guarded. Mr. Doran, the eminent book publisher, here tells why and how this may be brought about.

"First Radio Rights" for Authors

A New Development of "Literary Property" That Radio Is Bringing About

By GEORGE H. DORAN

"*UNLESS an author has or can cultivate voice personality, he or she should not attempt to give a radio talk or reading.*"

That is the message that I have sent to all of my authors. I consider it most important. A number of authors have given talks or readings by radio with probably harmful results, owing to poor delivery. They were inaudible.

At best, they did neither themselves nor their publishers good.

By "voice personality" is meant a very definite thing. The vaudeville interests have, I understand, forbidden their artists to give radio talks. I also understand that the loss to radio programs as the result of this restriction is almost negligible.

Why?

Because most vaudeville performers get their effect, after all, only with stage accessories—gesture, facial expression, costumes, background—and (above all), the presence of a large audience, each member of which encourages the others to laugh. Take away all these factors and strip the artist to his voice alone and how many of our popular entertainers can hope for any widespread success?

Apparently those who are first in line for success with the radio audience are those who have mastered the technique of making phonograph records. They have had to rely upon the voice alone. They have had to possess or develop what I am calling voice personality. On the other hand, this gift probably exists in a number of people. How far it can be acquired I do not know. But obviously it is of primary importance in a talk or reading to a radio audience.

I shall talk frankly to our authors about the matter of appearances on radio programs. I shall caution them not to attempt to give talks or readings unless they are reasonably sure of a clear and audible delivery. That is the first requisite. But more than that will be needed for any widespread success. They must have a theme of interest to great numbers of people; the radio audience is made up of all ages, of all degrees of education and of all conceivable varieties of taste. The appeal must be to the highest common divisor of that taste. It must be the highest appeal that can be made to each and every one of this vast crowd. That is what the author must start with; and what can be accomplished after that remains to be seen, but will depend very largely upon the author himself.

The fundamental situation in regard to radio is unusual. Here we have, already established, an instrumentality for entertaining and instructing a million or more people, all at the same time. These people do not pay a cent for this entertainment or instruction. Until some means is devised for charging an admission fee to the radio program it will be impossible to develop the first class radio artist, the person supremely gifted with voice personality, able to entertain and instruct the million. As soon as a device is hit upon for charging a few cents a night, radio programs will be immensely profitable enterprises. There will then be no question of the development of the radio artist nor of his monetary reward.

Then we shall have advanced to another stage; the authors who can appear successfully on radio programs will be materially enriched from that source and there will undoubtedly arise the question of what I may call "first American radio rights" in literary property.

These will have to be added to existing rights, such as first American serial rights, book rights, second serial rights, dramatic and motion picture rights.

"First American radio rights" in a book would consist of the exclusive right to broadcast throughout America by radio talks or readings the whole or parts of a copyrighted book. It is easy to see that the day will come when simple dramatic short stories and certain novels will be wanted to entertain the radio audience. The day is practically here now when books of instruction are wanted to attract and interest the radio audience.

The copyright law of the United States, at the present time, contains no specific provisions with regard to use of material in connection with radio telephones. However, Section One of the copyright act secures to the person entitled thereto the exclusive right in sub-section *c* "to deliver or authorize delivery of the copyrighted work in public for profit if it be a lecture, sermon, address or similiar production."

Probably that wording is ample to protect the rights of authors in copyrighted literary work when the radio goes on a money-making basis. So far as I know, those in charge of radio programs have shown every care not to use copyrighted material without permission; as the matter now stands, the use of such material is not, directly at least, "for profit," and permission is, by me at any rate, cheerfully granted.

But when the day comes for first American radio rights we shall have such novels, perhaps, as the first-class detective or mystery story, of the type that is provided with exciting climaxes at the end of every one or two chapters, desired for radio use. The reading of the story may easily not be by the author at all, but by somebody with the requisite voice personality. It does not matter.

Westinghouse

A "VOICE PERSONALITY" IS A GIFT THAT ONLY SOME AUTHORS HAVE

An author who reads from his own works must be sure of an audible delivery and he must have a theme of general interest. One of the most popular is Howard Garis, whose "Uncle Wiggly Bed Time Stories" are known to millions.

The point will be that for the use of the book, the author must be properly paid. I do not anticipate the slightest difficulty in fixing what the author shall be paid, tentatively, until the market for first American radio rights shall be established; I merely speak of this by way of normal prevision.

I was much interested by the broad basis upon which Mr. J. W. Hiltman, President of D. Appleton & Company, reasoned in regard to radio. Mr. Hiltman gave it as his emphatic opinion that anything which keeps the family at home is bound to be good for books. He says that people who form the habit of staying at home will, sooner or later, read books. I think so too. I am more interested in how the approach shall be made—in what books they do read or will want to read and in what ones of our books already published or about to be published they can most readily be interested.

I should be willing to undertake, if it could be arranged, an experiment with any of our books to determine what types of books the radio audience likes best. At present, little is known along this line. Almost the only point that has conclusively been proven, through authors' readings given so far, is the immense popularity of bedtime stories for children. This is of an importance to the authors of children's books that it is not easy to exaggerate. But there are endless books in which I foresee a widespread interest, once the radio audience knows about them.

One of our authors, for example, tells in a humorous and sane way about weight reduction—a subject of no small interest to a very large number. Those whose weight satisfies them can still enjoy the humor of the book. The same author has written a novel of interest to anybody who drives a car, especially if he has taken or contemplates taking a transcontinental trip. The material of which these books are composed is exactly the sort of thing that should interest a radio audience.

During the recent visit of Sir Arthur Conan Doyle to this country, overflowing crowds have come to the halls to hear his lectures on spiritualism. Most of those who came, I don't doubt, did not believe in the possibility of communicating with the dead, but they were interested in what Sir Arthur had to tell. Many thousands heard him; why not a million?

That is what radio ought to mean to books and authors and publishers. It ought to mean a hitherto unrealized possibility in the way of audiences. It ought to mean that through hearing an author talk over the radio telephone on some subject in which he is interested, a man would go out and buy that author's book; or though he heard not the author himself, but someone with the requisite voice personality reading from the author's book, the same result would follow. It is a chance for those who feel that natural personal interest in an author whose works they enjoy to hear his voice or to learn those personal details which are of interest to his readers.

For my part, I see in radio only a valuable instrumentality for furthering the cause of good reading. When the telephone was invented the book publisher proceeded to use it to the feasible extent in furthering the cause of books. When the phonograph was perfected, a chance to link that new instrumentality with the cause of good reading was probably missed—although I hope not finally. Now the radio is here. It is a tremendously multiplied lecturing platform; it is a new and more fascinating phonograph; it is the telephone in a million homes. I shall leave undone nothing that occurs to me to realize to the fullest imaginable extent its powerful aid.

How *to* Make Your Bed Talk *to* You

By S. R. WINTERS

NO longer can the phrase "falling in the arms of Morpheus" be properly used as a symbol of sleep. No longer need one retire attended by the silence of the bed chamber at night. For science has waved its wand and endowed the bed with the gift of speech and of music. In other words, your bed springs may be used as an aerial for the reception of stories, lectures and music transmitted by radio.

Just how this feat may be accomplished has been demonstrated by Mr. H. G. Corcoran of Washington, D. C., who has literally converted his bedroom into a radio station with one unusual feature.

A towering antenna as well as the elaborate fixtures that project from the housetop is eliminated by Mr. Corcoran's innovation. The antenna lead is affixed to the springs of the iron bedstead, and the ground connection is effected through the means of a water-pipe and radiator in the sleeping quarters.

This radio-telephone receiving outfit is of a single-circuit regenerative design. Its source of strength—or electric current, to be exact—is imparted by a 6-volt, 60-ampere battery. Two variometers; two condensers, one with vernier attachment; one detector tube, and one-stage of audio-amplification from two "B" batteries are the operating units which work in harmony to insure the reception of music and vocal speech from near and distant points. Three pairs of head telephones are connected to the equipment. Vibration sound, to repeat common knowledge, is not barred by walls and the reception is not hindered by the fact that this wireless receiving set is contained within closed quarters. To paraphrase the axiom, "Prison walls do not a prison make," the installation of a radio-telephone receiving equipment does not insure isolation even though one be enclosed securely by stone and mortar.

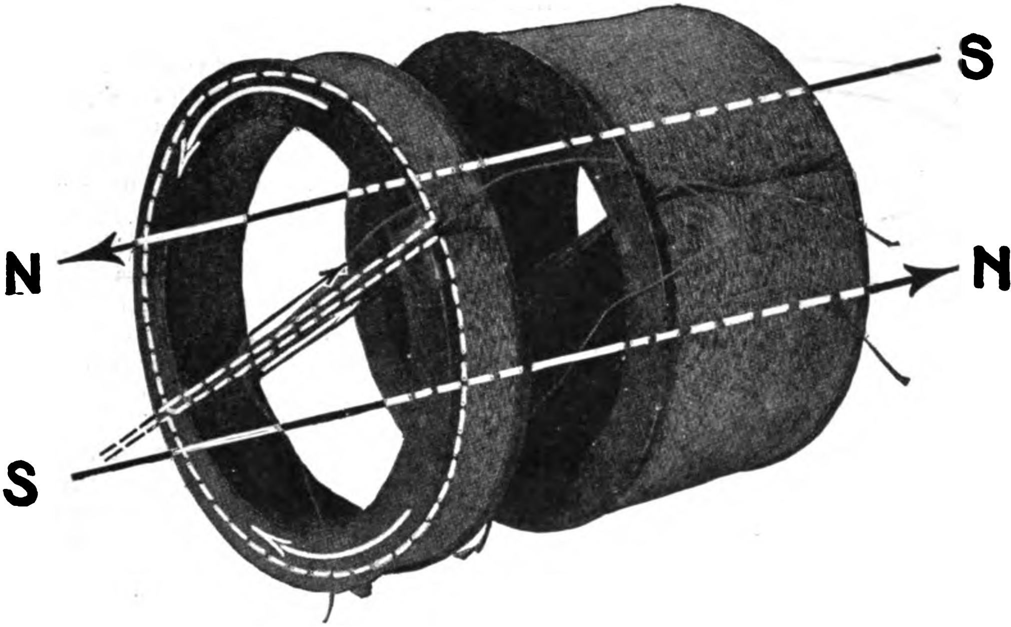
"Now listen, my children, and you shall hear how the elephant got his trunk," may be the introductory sentence to a bed-time story that seeps its way into the room of this Washington citizen who has distorted the heretofore single purpose of the bed-springs. Mr. Corcoran, by a mere twist of one of the knobs on the apparatus illustrated in the photograph, can adjust the receptive "moods" of this outfit to a point of receiving music or messages from Detroit, Springfield, Schenectady or Newark. Radio transmitting stations that are not so far removed as these may occasionally be heard distinctly.

Fans who ransack the ether for its contents may duplicate this unusual procedure and thus contribute to their own pride and satisfaction by having a receiving set that is distinctive. Mr. Corcoran used much pre-war material in building his own outfit. Radio fans who contemplate summer excursions into the woods or fishing trips that will take them far from the city may investigate the desirability of carrying along their bed-springs. This household unit now can serve a two-fold purpose—contribute to the comfort of peaceful sleep, and relieve the monotony of existence when you are alone.

© Harris & Ewing

A NOVEL RECEIVER THAT REALLY WORKS

The apparatus, which consists of a regenerative receiver and amplifiers, gathers energy from the springs in the bed, which thus serve as antennae. Such a set can pick up nearby stations—but a bedspring hardly compares with an outdoor aerial in efficiency.



TWO "FIGURE 8" COILS AS A VARIOCOUPLER

The dotted lines in the photo-diagram show how the winding is made to give the coils a double magnetic field, as shown by the large arrows. Two coils coupled together in the position shown produce a maximum coupling; but if one of them should be revolved on its axis 45 degrees the coupling will be zero, as the fields will neutralize each other.

How to Make a NOVEL VARIOCOUPLER

Another of the Series of Practical Articles That Tell the Novice How to Build His Own Apparatus at Low Cost

By A. HYATT VERRILL

A FORM of variocoupler which seems but little known to amateurs and novices and which is a simple and efficient type, is that built of what are known as "Figure Eight" coils. To make a really good variocoupler with the secondary coil in the form of a rotor is a difficult job. Rotary ticklers in tube form will give results, yet the coupling is never as satisfactory as with a round rotor. But with the Figure Eight type of variocoupler no inside rotor is required, the secondary consisting of a second coil placed at one end of the primary and in the same plane with it and rotating on an axis parallel to that of the large coil.

Owing to its peculiar construction—with the winding going first in one direction and then in another forming a coil with four poles—a wide range of coupling may be secured with a 45 degree rotation of the secondary coil. The result is a tuner which has the qualities and advantages of a variocoupler and at the same time is simple to construct.

To make this coupler you will require a

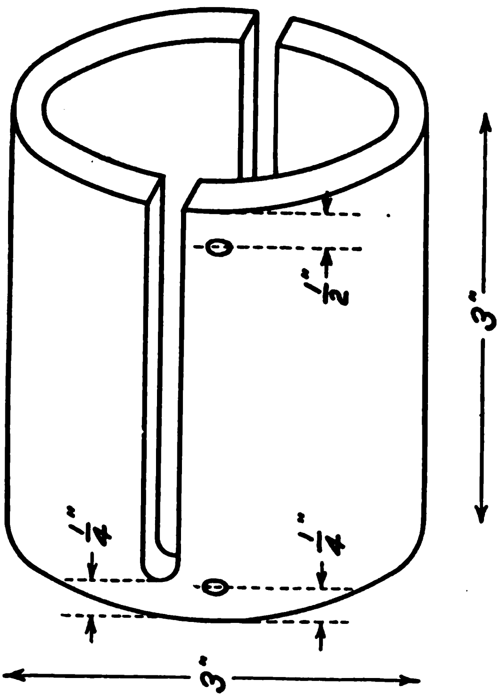


FIGURE 1

The larger tube (for the primary coil) should be made according to the dimensions in the above diagram.

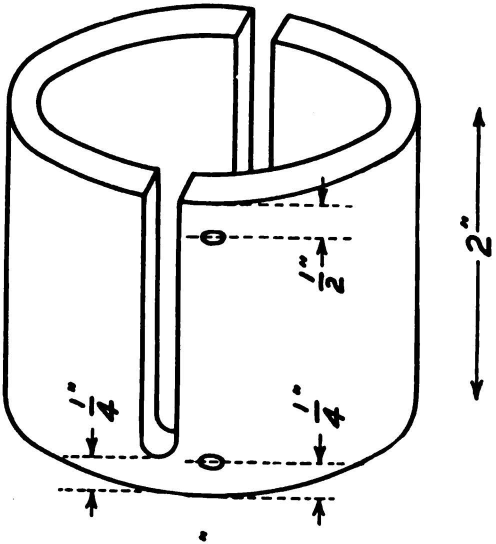


FIGURE 2

The smaller or secondary tube should be made like the larger tube—but with the dimensions here shown.

supply of No. 20 or 22 cotton or silk insulated wire; two formica or composition tubes, both three inches in diameter and one three inches and the other two inches in length. You should also have a ten point switch, two discs of wood of the same diameter as the inside of the tubes, a short section of ¼ inch brass rod or a long ¼ inch brass bolt, brass washers, binding posts and nuts.

Commencing with the larger or primary coil, by means of a straight edge, draw a line or scratch marks upon the edges of the tube across the exact centre. This will be easier to do if you draw a line across the centre of one of the wooden discs and then, by placing this in one end of the tube, mark where the ends of the line come on the tube.

Having determined this, draw a line from each of these marks to within one-quarter of an inch of the opposite end of the tube. Keep these lines parallel with the axis of the tube and then, with a hack saw, cut through the tube along these lines. Be careful not to use too much force, but work slowly and easily so as not to break the tube. The result should then be as shown in Figure 1.

Repeat the operation on the small tube, Figure 2.

Now bore a hole near the end of one of the cuts in both tubes and another hole near the cut and half an inch from the other end of the tubes. (Figures 1 and 2.) Run one end of the wire out through the hole that is a quarter inch from the end of the large tube, leaving several inches projecting, secure it in place by sealing wax and proceed to wind on the wire as shown in Figure 3. Starting at the hole where the wire is fastened, take a turn up through the slit, around the half of the tube and through the opposite slit, bringing it across to the first slit near the starting place. Then bring the wire in a turn around the opposite side of the tube from the first as in Figure 4, carry it across the tube through the slit, wind around beside the first turn and thus continue winding first in one direction on

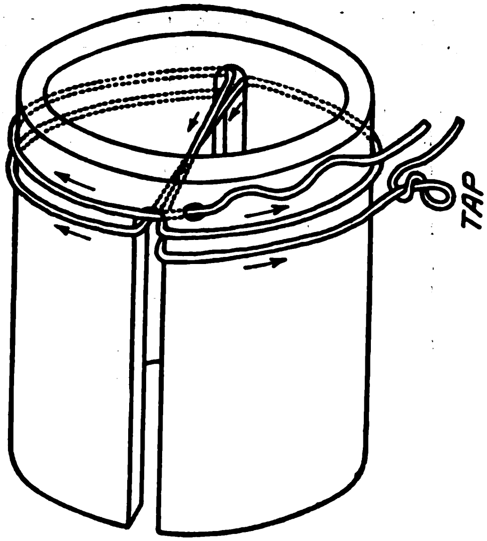


FIGURE 3
How to start the winding of the wire on the primary coil. Compare this diagram with the one on page 201.

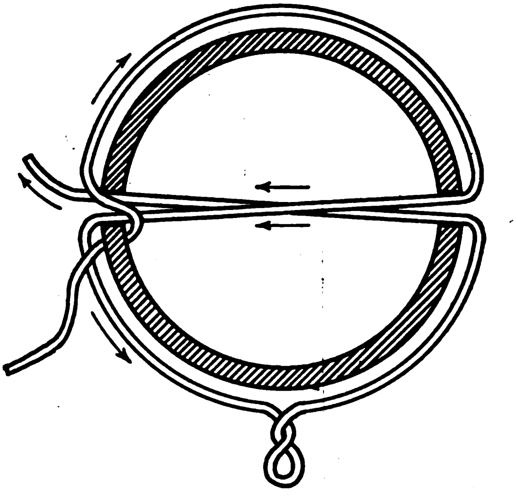


FIGURE 4
How to make a tap. In the winding of a coil, a tap should be made at every ten turns until nine taps are made.

one-half the tube and then in the opposite direction on the other half of the tube, making a series of figure 8's with the winding. When the tenth turn is reached make a tap in the usual manner and continue winding until the twentieth turn on the same side as the first tap is reached, then take another tap.

Go on winding in the same way, taking a tap at every ten turns until ninety turns and nine taps are made. Then pass the wire through the hole near the end of the tube and secure it with sealing wax. Next, fasten one of the wooden discs in this end by means of small brads or screws and secure the disc in whatever way you see fit to a bracket or similar support as shown in Figure 5.

Next start with the smaller tube in exactly the same way, fastening the end of the wire at the hole nearest the tube end and winding on the wire exactly as on the large tube, but without taking any taps. When seventy turns have been taken, fasten the wire in the hole, leaving a fairly long free end.

You must next decide what sort of adjusting device and mounting you are going to use for the coupler. If it is to be mounted on a panel, a bracket on the primary as shown, with the secondary mounted with a shaft running through the panel, is both convenient and neat. In this case, the shaft that bears the knob should be secured to the wooden disc by means of two nuts. Washers soldered to the shaft with loose washers as bearings should be provided or (if preferred) loose washers and cotter pins may be used. It makes little difference which method is employed so long as the coil cannot move out and in and thus vary the distance between it and the primary coil. The accuracy with which the two are fitted together has a great deal of influence upon results, for if the secondary wobbles or varies in its distance from the primary the coupling will be unevenly variable. The whole idea is to keep the tubes and the two windings as close together as possible.

A simple method of mounting is shown in Figure 6, in which both coils are mounted on a panel or base by means of brackets. The shaft used to rotate the tickler should be accurately centered in the wooden disc and the latter should be fitted and fastened securely within the

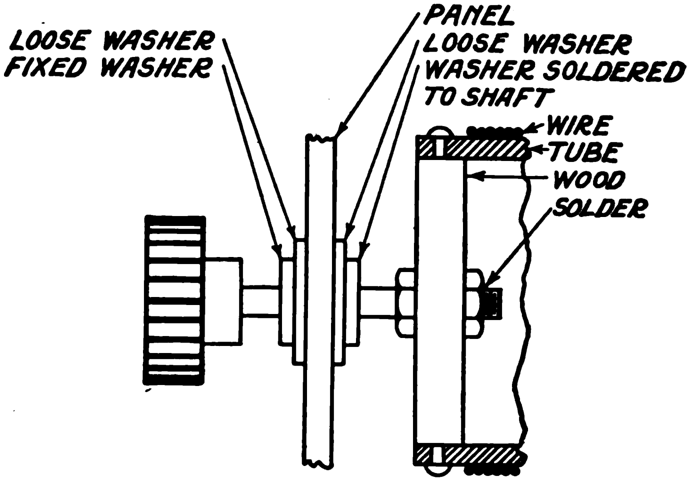


FIGURE 5
How to fasten the rotating secondary coil to the panel, with the control knob attached.

tickler coil by means of small screws driven in through the half-inch bare space left on the tube for the purpose. Do not slight this part of the work, but take just as much care in fitting the wooden ends and fastening them and in mounting the complete coupler as in winding the coil or finishing the cabinet or panel. It is neither good workmanship nor common sense to spend a lot of time and trouble as well as good material in making a coil or any other device and then, either because you are in a hurry to test it or because you get tired of the job and wish to finish it quickly, slight the last part of the work. Many a well-made instrument has been cast aside as worthless just because the maker slighted some little thing near the finish of the job. If you have done careless work it is of little use to try to make up for it by placing the instruments in an elaborate and highly polished mahogany cabinet with engraved dials and Bakelite panel. Remember the old Romans' adage, "The gods see everywhere," and do not think, because your careless work is invisible, that it will "get by." There are no more

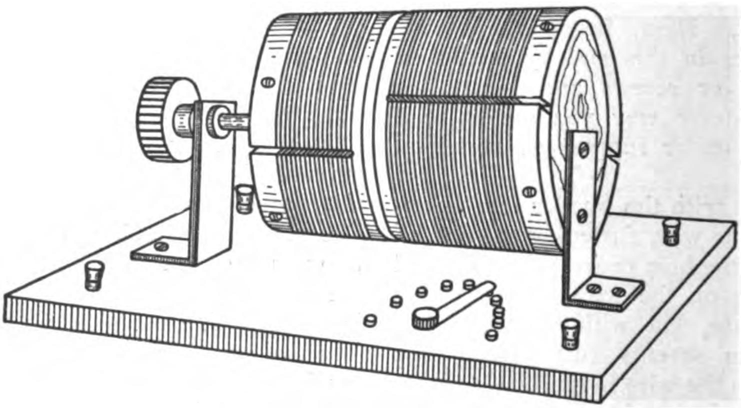


FIGURE 6
A simple method of assembling the variocoupler on a board for experimental use. Be careful not to slight this part of the work.

unsparing inspectors than radio waves; when they enter that beautiful looking cabinet and find poor or careless work inside they will shout the fact aloud to you and to your friends by squeals, buzzes and howls instead of good clear signals.

Figure 7 shows the completed Figure Eight coil variocoupler, the secondary of which may be connected up with a suitable crystal or vacuum tube circuit.

The variocoupler may be mounted on a panel so that the control knob protrudes from the front of the panel; in this case the primary switch and the switch-points should also be mounted likewise, so that the instrument may be placed within the cabinet that contains the other parts of the set.

The best way to tune the secondary circuit is by the use of a variable condenser shunted across the secondary winding, although in some vacuum tube sets a variometer is connected in series with the grid of the tube, and the tuning is accomplished by this means.

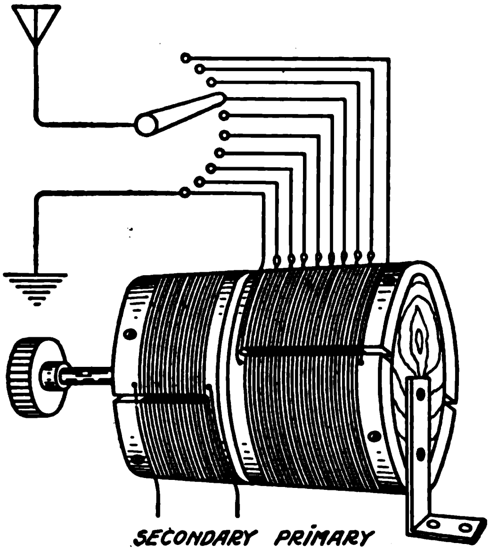
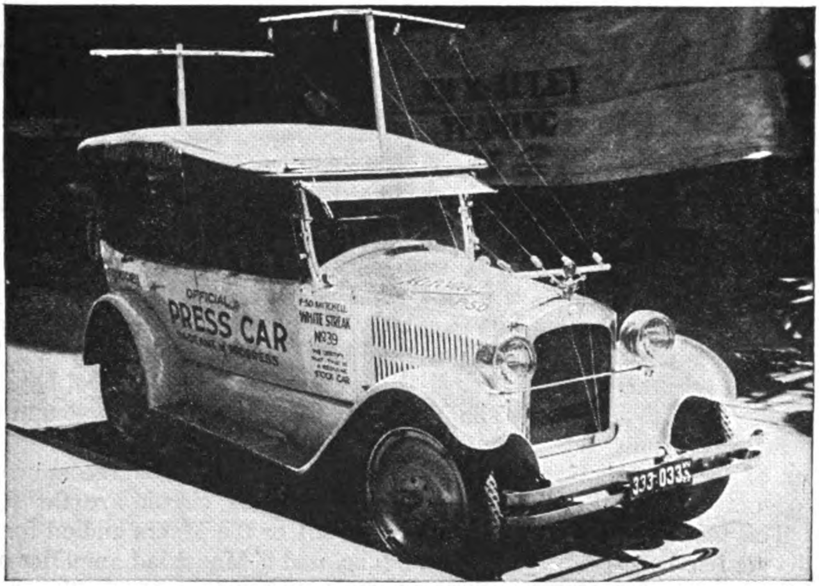


FIGURE 7

The completed Figure Eight Coil Variocoupler, showing how to hook up the primary circuit. The secondary circuit can be connected to any standard crystal or tube circuit.



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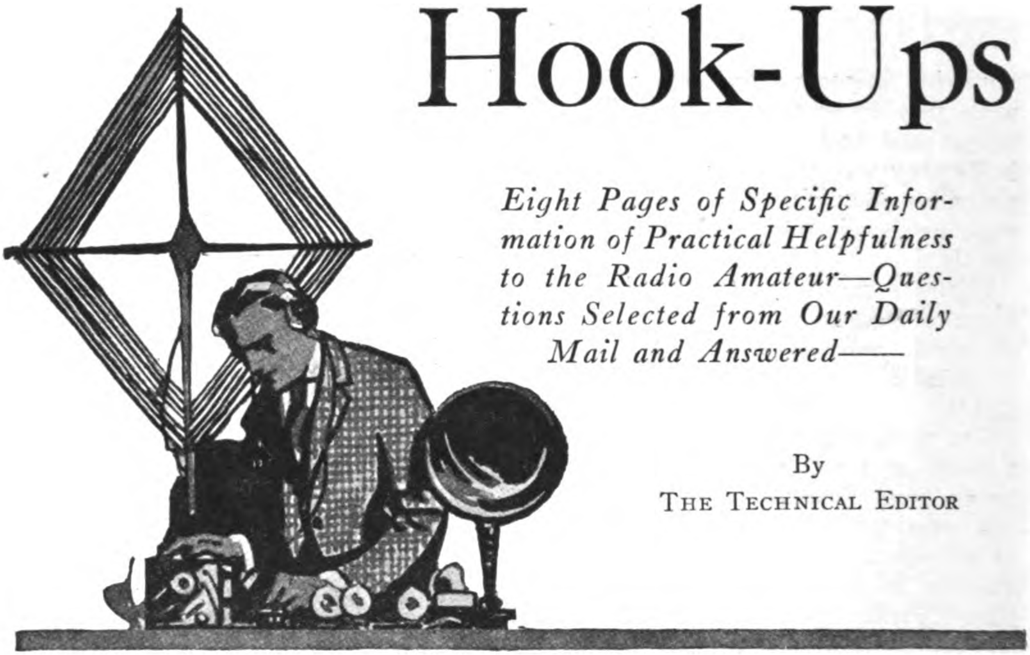
HOW TO INSTALL A RADIO SET ON YOUR MOTOR CAR

Despite the number of fake installations devised for publicity purposes, which have given rise to misconceptions on the subject, the equipping of an automobile with a workable receiving set is entirely practical. The several ways of doing it will be told in the next issue of POPULAR RADIO.



Hook-Ups

Eight Pages of Specific Information of Practical Helpfulness to the Radio Amateur—Questions Selected from Our Daily Mail and Answered——

By
THE TECHNICAL EDITOR

THE information embodied in this feature is ordinarily furnished in the department, *What Readers Ask,* which is published regularly in POPULAR RADIO. In order to make this department of greatest help to the beginner, it is possible to publish only those questions and answers which are of the widest application and of most general interest. To insure prompt attention and to help the Technical Editor in handling the large amount of correspondence which the department has developed, our readers are asked to observe the following requests:

1. **Confine each letter of inquiry to one specific subject.**
2. **Enclose a stamped and self-addressed envelope with your inquiry.**
3. **Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.**

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

IN answer to the hundreds of requests that have come pouring in on the Technical Editor for additional data on the super-regenerative circuit (described in the September number), the following notes on the super circuit have been prepared. These notes embrace improvements and hints for those who are building or who have built sets from the description of the set that was published in these pages.

First. The method of connecting the loop to the set has been modified so that any sized loop may be used; tuning is accomplished by varying the switch taps of the coil "F" and rotating the condenser "C," which is in series with the loop. See Figure 1, in which the hook-up is given and the method of tapping the "F" coil is clearly shown.

Second. The "C" battery in series with the grid of the second tube has been eliminated, and only two batteries are used, as in the ordinary vacuum tube set, the "A" and "B" batteries.

Third. The tubes recommended for use with this circuit are the Radiotron UV-201 or the Myers audion for the first tube, and a Moorhead amplifier or W. E. "J" tube for the second tube.

Fourth. The circuit shown in Figure 1 may be used with the telephones by tuning out the signals a little so that they will not hurt the ears, or it may be used with a loudspeaker just as it is. The signals with the two tubes should be loud enough to fill a good-sized room using a loop. If the signals are wanted strong enough to fill a large hall, however, a one or two-stage audio frequency amplifier should be added to the set. A one-stage amplifier will produce signals that will be audible over a house, upstairs and downstairs; a two-stage amplifier will make them audible for a quarter of a mile or more, according to the tubes used, the type of loudspeaker employed, and the tuning ability of the operator. The input terminals of the amplifier should be connected to the two leads of the set marked "xx" in Figure 1.

Fifth. If the amateur builder has trouble in getting the set to operate properly after he has checked up all connections and parts, he will do well to try reversing the terminals of the coils "F," "A," and "B" one at a time.

Sixth. When a "saw-tooth" heterodyne (whistling) effect is heard while tuning with the condensers or the variometer, the builder will know that he is getting nearer to success in making his set work properly; when this sound is heard it is merely a case of becoming familiar with the adjustment.

Seventh. An antenna may be used with the set, if the antenna is attached to the loop by means of a clip. The correct turn of wire on the loop to which the outdoor antenna is to be attached will be determined by experiment while tuning. No changes are made in the circuit for using the outdoor antenna, and no ground is used. This will bring in the distant stations louder without increasing the nearby stations.

* * *

QUESTION: In a regenerative type set composed of two variometers, one variocoupler, and a variable condenser, what are the controls that govern the regeneration of the incoming signals? Please tell me, also, the proper method of tuning.

WILLIAM PRESTON

ANSWER: Regeneration is accomplished in this type of set by rotating the plate variometer. We refer you to the article by E. H. Felix in the May issue of POPULAR RADIO, entitled "How to Tune a Regenerative Receiver."

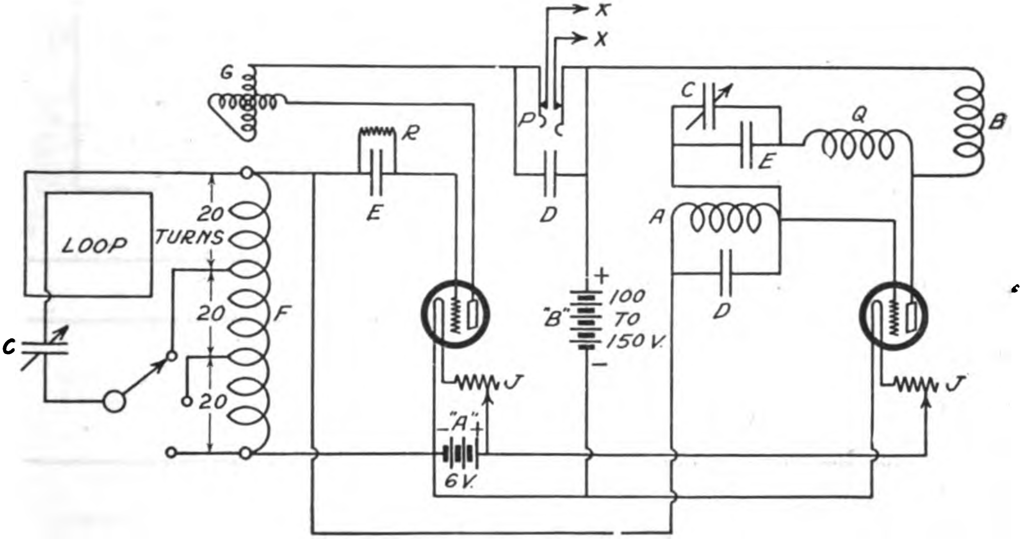


FIGURE 1

The two-tube super-regenerative circuit which has proven so successful. Note that the use of "C" batteries is dispensed with. An audio frequency amplifier may be connected to the two wires marked "XX," and the signals increased to terrific strength.

Question: I have a crystal set with a two-slide tuning coil. Could I use a loop aerial and would it work as well as the horizontal type of aerial?

R. Gemmecke

Answer: A crystal detector is not sufficiently sensitive to use with a loop antenna with any measure of success. We advise you to stick to the outdoor antenna until you decide to install a more sensitive set with some form of radio frequency amplification. You would otherwise obtain no results.

* * *

Question: Would it be possible for me to use one stage of radio frequency with one stage of audio frequency amplification? If so would you please print a circuit using a set of Goodwin untapped spiderweb coils together with said amplification?

J. H. W.

Answer: This is possible, and the circuit is shown in Figue 2. L1, L2, L3 are the spiderweb coils, L4 is a single slide tuning coil, C1 and C2 are variable condensers, .001 mfd. capacity, C3 and C4 are fixed condensers, .0005 mfd. capacity, R1 and R2 are resistance potentiometers, 200 ohms, R3 is a grid leak resistance, 1 or 2 megohms, and R4, R5, and R6 are filament rheostats, 6 ohms each. 22½ volts are used on the detector plate and 90 volts are used on both the radio frequency and the audio frequency amplifier plates.

* * *

Question: Would it make any difference what size variable condenser I have in the receiving set described in the July issue of Popular Radio, on page 194?

James H. Hind

Answer: Any condenser with a capacity value lying between .0005 and .001 mfd. will be suitable, although the larger capacity the condenser has, the higher the wavelength to which the set will be able to tune.

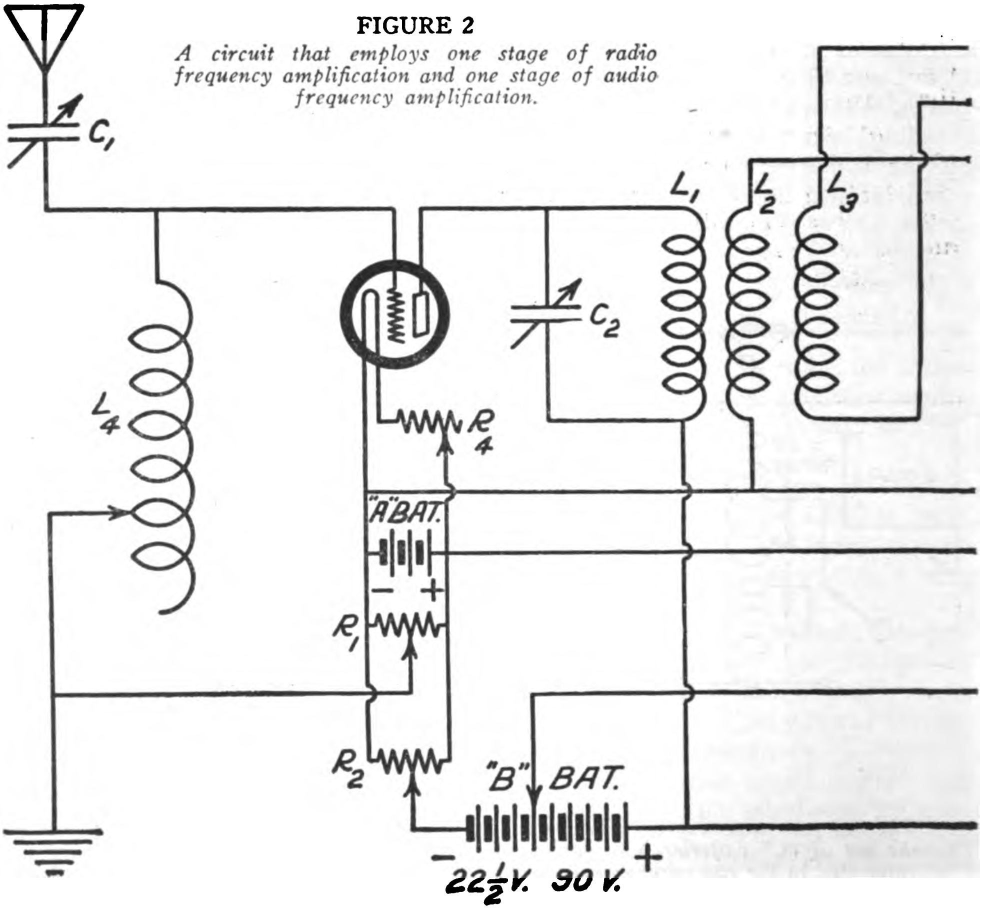


FIGURE 2

A circuit that employs one stage of radio frequency amplification and one stage of audio frequency amplification.

Question: Please inform me if a coil may be tuned with a variable condenser as well as with sliders; I mean the primary coil of a loose coupler.

R. M. B.

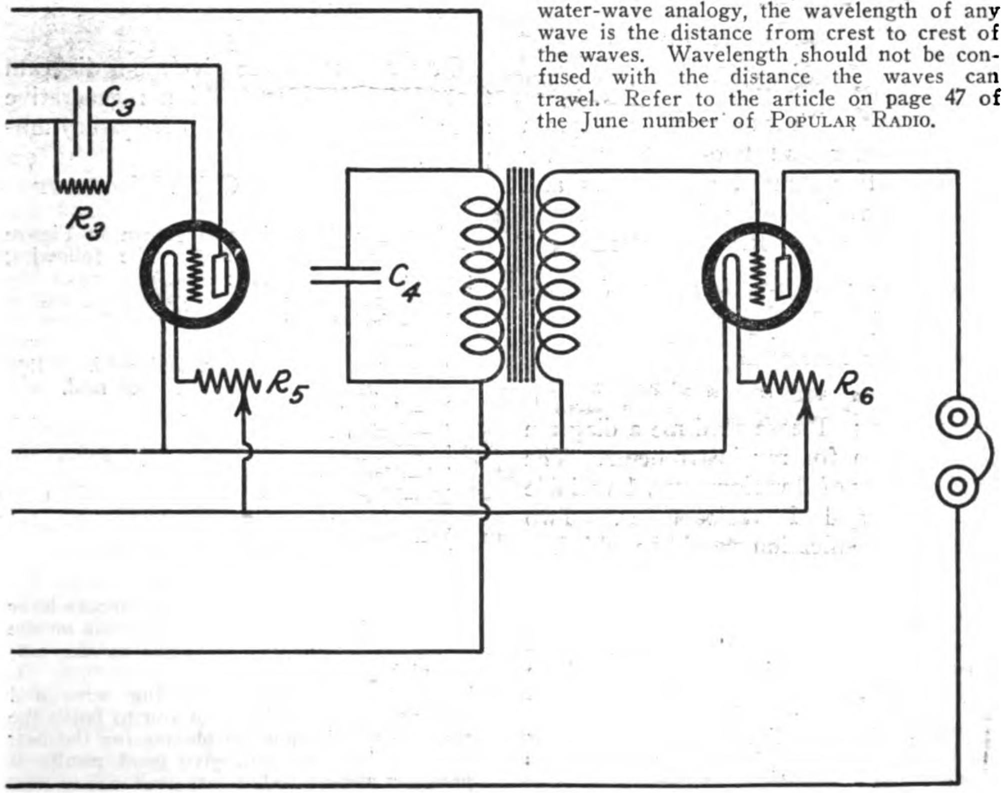
Answer: The wavelength of an antenna circuit having in it the primary circuit of a loose coupler may be tuned satisfactorily by means of a variable condenser. In fact, if the condenser is used with a series-parallel arrangement, it makes tuning possible over a broad band of wavelengths.

* * *

Question: What would be the best kind of tube to use in the set described on page 295 of the August issue of Popular Radio? In that set would it not be just as good to put the variable condenser in series with the lead-in from the antenna?

George Saunders

Answer: Any soft detector tube such as the UV-200, or the Cunningham 300, or an Electron Relay, will be serviceable for use with this circuit. The circuit will function better as shown in our diagram, with the antenna circuit tuned with the slider and the secondary circuit tuned by means of the variable condenser.



* * *

Question: What are "damped" and "undamped" waves? What do we mean by "wavelengths from 200 to 700 meters"? In other words, to what does "wavelength" refer?

Glenn E. Dill

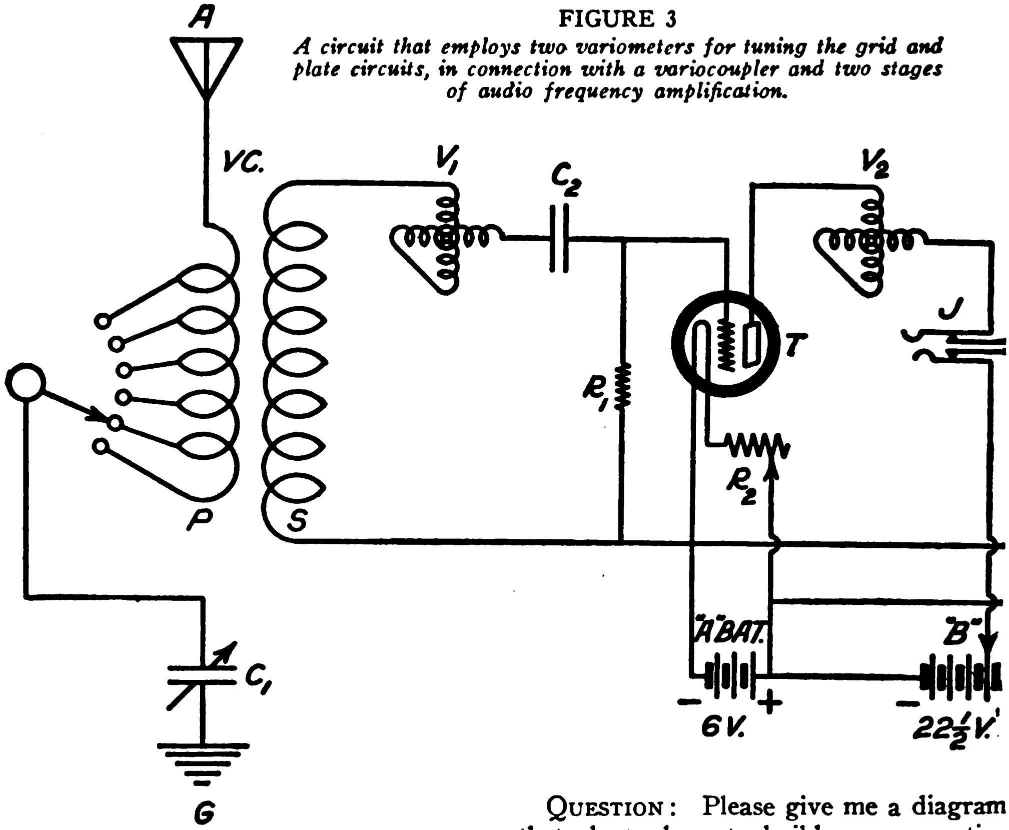
Answer: An "undamped" wave refers to an alternating current in which the amplitude of each succeeding alternation is constant. This is the type of energy developed by a vacuum tube transmitter, an arc transmitter, or a high frequency alternator.

A "damped" wave refers to an alternating current in which the amplitude of each succeeding alternation is of a decreasing value. This dampens out the oscillations in a circuit so that they finally die out. This series of oscillations is called a wave-train, and is generated by a spark transmitter. There is a wave-train generated for each spark jumping the gap in such a transmitter.

By "wavelength" is meant the distance traveled by a radio wave upon leaving an antenna before the next wave generated leaves the antenna. By referring to the water-wave analogy, the wavelength of any wave is the distance from crest to crest of the waves. Wavelength should not be confused with the distance the waves can travel. Refer to the article on page 47 of the June number of Popular Radio.

FIGURE 3

A circuit that employs two variometers for tuning the grid and plate circuits, in connection with a variocoupler and two stages of audio frequency amplification.



Question: Please give me a diagram for a detector and two-stage amplifier set, using two Amrad variometers and an Amrad variocoupler for tuning.

R. A. McMillian

Answer: The diagram has been drawn for you in Figure 3. This should make a very fine receiver for both amateur work and broadcast reception.

* * *

Question: Please send me a diagram of a hook-up for my instruments. The tuner consists of 2 variometers, 1 variable condenser, and 1 variocoupler. Two stages of amplification should be added.

Everett Beers

Answer: Refer to the diagram in Figure 3 for the circuit connections for your proposed set. You will notice that telephone jacks are inserted in the plate circuits to cut in or out of amplification.

The variocoupler and variable condenser tune the antenna, while the two variometers tune the grid and plate circuits.

Question: Please give me a diagram that shows how to build a regenerative set, adding a 2-stage audio frequency amplifier.

C. W. Woodruff

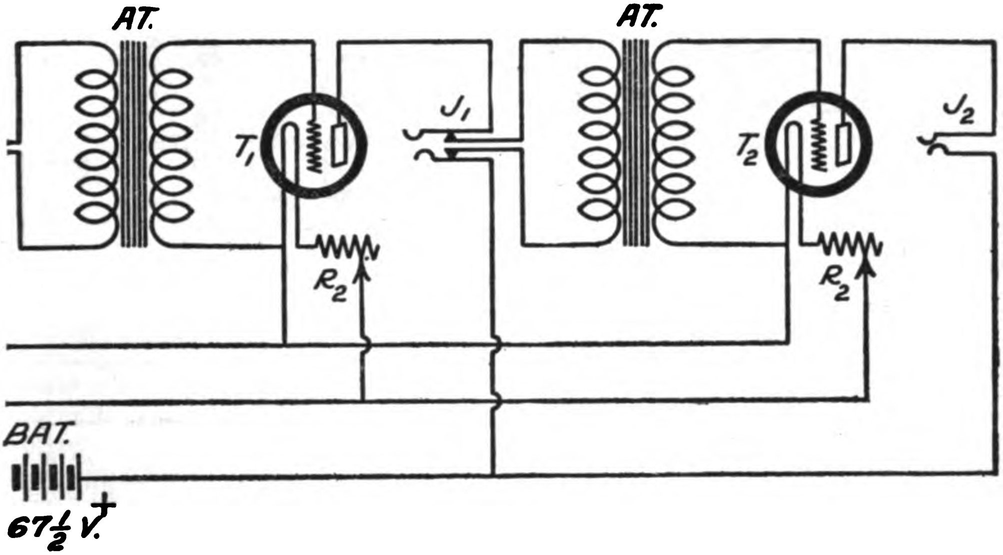
Answer: The diagram shown in Figure 3 gives you the hook-up. The following parts will be required:

V1—Variometer
V2—Variometer
VC—Variocoupler
C1—Variable condenser, .001 mfd.
C2—Fixed grid condenser, .0005 mfd.
R1—1 megohm grid leak
T—6 ohm rheostat·
T—Vacuum tube UV-201
T1—Vacuum tube UV-201
T2—Vacuum tube UV-201
J—Double circuit jack
J1—Double circuit jack
J2—Single circuit jack
AT—Amplifying transformer
A—6-volt storage battery, 60 ampere-hour
B—"B" battery dry cells, 22½ volts on the detector tube and 90 volts on the amplifier tubes

Three tube sockets, connecting wire and binding posts should enable you to finish the set. Use 3,000 ohm telephones for the best results. This set will give good results if properly constructed.

Question: Please tell me if a variable condenser will tune out the terrible popping static that I hear over my crystal set. I also want to know if there is any addition I can make to my set that would increase the volume of music that I hear 25 miles away on 360 and 483 meters.

Irving Rust



Answer: The variable condenser will not help you tune out the static. You would find some relief if you were to use a loop antenna, but this necessitates using multi-stage radio frequency and audio frequency amplification for loud signals. You will be able to increase the volume of your received signals by adding a vacuum tube to your set as a detector in place of the crystal detector, and at some future date adding another vacuum tube as an amplifier.

* * *

Question: I would like to know which is the better plan—to amplify before I detect, or *vice versa.*

Robt. Fard

Answer: In radio frequency amplification, the incoming impulses are amplified before they are detected, and when audio frequency amplification is used the impulses are detected and then the low frequency component of the current is amplified.

Radio frequency amplification is more suitable for amplifying weak signals so that the detector is furnished with enough current to function, and audio frequency amplification is used when the signals have already been detected and when signals of sufficient strength to operate a loudspeaker are required.

The two systems of amplification cannot be compared because they have different functions. The best results are obtained when the two systems are employed in combination and amplification is obtained both before and after detection.

* * *

Question: Please explain the method of amplifying the signals as received with a single crystal detector, by means of additional crystals and amplifying transformers, and state the degree of amplification obtained.

E. O. Knoch

Answer: The technical editor has seen the diagram of such a circuit, but he is "from Missouri" in regard to its practical application. It stands to reason that in the crystal detector receiver, the strength of the received signals is a function of the current passed through the crystal. If we step up the voltage by means of amplifying transformers, the current in the next crystal is decreased and the signal is weakened. If, on the other hand, we should step down the voltage in order to increase the current through the second crystal, the voltage would be of too low an order to overcome the high resistance of the crystal and again the signals would be weakened. If this method were successful it would very probably be in common use. Our advice is to stick to the vacuum tube as an amplifier.

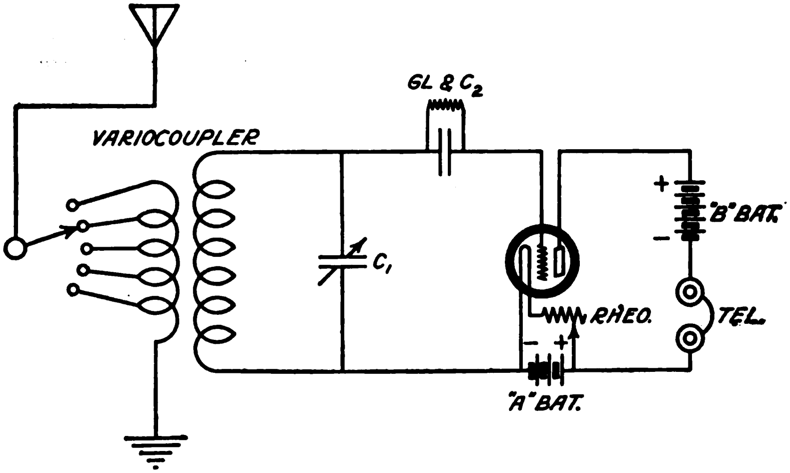


FIGURE 4
A circuit that makes use of a variocoupler, a variable condenser, and a vacuum tube.

QUESTION: Please show me an efficient diagram using a variocoupler, a variable condenser and a vacuum tube detector.

HENRY C. JONES

ANSWER: The circuit diagram you require is shown in Figure 4. The tuning is accomplished by means of the primary switch and the variable condenser.

* * *

QUESTION: I have already made a receiving set a little different than the one described in your May issue, but I have had very little luck with it so far. I enclose the hook-up that shows the instruments I use, and the antenna. Can you find my error?

CECIL LAMGKUR.

ANSWER: You will improve your set if you use the circuit for hooking up your apparatus as illustrated in Figure 5. The antenna you have is much too small. Use one wire stretched as high as possible and at least 100 feet in length (but not longer than 150 feet) for listening to the broadcasting programs.

* * *

QUESTION: I have a loose coupler, a fixed condenser and a crystal detector. Can I make a set out of them that will receive code messages and music? If so please give me a wiring diagram for the set.

D. STAFFORD

ANSWER: A circuit employing the instruments that you have on hand is given in Figure 5. This will allow you to receive local code and broadcasting quite clearly.

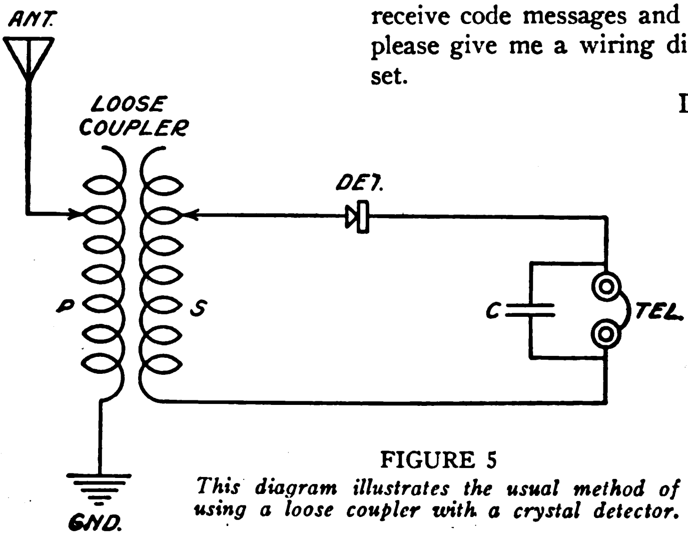


FIGURE 5
This diagram illustrates the usual method of using a loose coupler with a crystal detector.

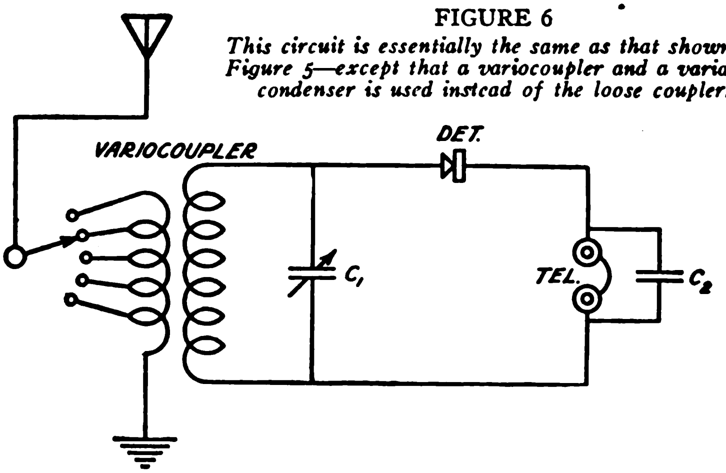


FIGURE 6

This circuit is essentially the same as that shown in Figure 5—except that a variocoupler and a variable condenser is used instead of the loose coupler.

Question: Please give me a diagram showing how to wire up a variocoupler tuning coil with crystal detector and where to put the variable condenser. My aerial is 100 feet long and 30 feet from the ground, made of No. 14 bare copper wire without an enamel coating on it. Will it be all right without the coating?

P. A. Latta

Answer: The diagram that you require is drawn for you in Figure 6. The bare copper wire will be suitable.

* * *

Question: Which is the best, a loose coupler, a variocoupler, or a variometer? How many miles would I be able to receive with one of the above, and a phone condenser, a 43 plate variable condenser, a crystal detector, and a pair of 2,200 ohm phones?

John Collins

Answer: The variocoupler will give you the most satisfactory method of tuning. See the diagram shown in Figure 6 in answer to the question of P. A. Latta. It is not possible to answer questions regarding the distances over which a set should receive.

* * *

Question: Is there any way in which the set described in the July issue of Popular Radio (on page 194) can be made to receive over greater distances? I hear the local stations clearly but want to increase the range.

T. J. Laughlin

Answer: On page 168 of this magazine you will find another article by Watson Davis; it shows how to add a vacuum tube detector to the set you describe, thus increasing its range considerably.

* * *

Question: Please give me an efficient hook-up for the following instruments:

1 variable condenser
1 fixed condenser
1 variocoupler with a tapped primary
1 crystal detector
1 pair of head-telephones

Henry C. Jones

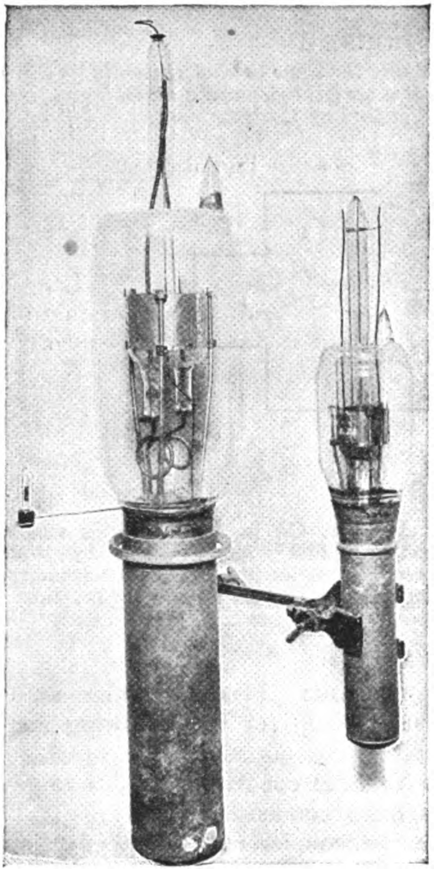
Answer: The hook-up is shown in Figure 6.

* * *

Question: Can a 6-volt and a 22½-volt D. C. generator be used, instead of the "A" and "B" batteries respectively, in a vacuum tube receiving set?

Victor Neher

Answer: These may be used providing the direct current, generated by the machine, is non-fluctuating. If the current is of a pulsating nature, such as is generated by most machines of small size, there will be a humming sound accompanying the reception that will cause interference. This may be eliminated by the use of a filter circuit connected in the plate circuit of the tube. Such a circuit was described and a diagram given on page 144 of the June issue of Popular Radio. The filter circuit shown on this page is one recommended for use with a radiophone transmitter, but it can be used advantageously for receiving sets.



Compare the tiny tube (which is still used for receiving) with the latest 100 kilowatt oscillator which has just been produced—the most powerful vacuum tube in the world, 100,000 times as powerful as its companion. The tube at the right is the 10 kilowatt oscillator from which it was developed.

The "Peanut" Tube's Giant Brother

The latest and the most powerful of vacuum tubes that weighs but ten pounds—but that may conceivably do the labor of $500,000 worth of machinery

By W. WILSON

Introductory Note

Here is a description of an amazing triode, scarcely two feet in height and weighing only ten pounds, that is nevertheless capable of delivering 100 K. W. of high frequency energy—truly an "Aladdin's lamp" of radio raised to the *n*th power. It is not inconceivable that this tube may become one of the most remarkable devices of modern electrical science.

Vacuum tubes capable of handling small amounts of power have been extensively used during the past few years as telephone repeaters and as oscillators, modulators, detectors and amplifiers in radio transmission and other fields. Practically all such tubes have depended upon thermal radiation from the plates to dissipate the electrical energy which the device necessarily absorbs during its operation. With present methods of construction, and using glass for the containing bulb, a fairly definite upper limit can be set for the power which a radiation cooled tube can handle; as the author points out, this limit gives a tube capable of delivering about 1 to 2 K. W. when used as an oscillator.

Contrasted with this is the large water-cooled vacuum tube described herewith. Another tube of similar construction, but somewhat smaller in size, is capable of delivering about 10 K. W. It is expected that these water-cooled tubes will find important application in radio telephony and telegraphy.

Although the principle of operation of the water-cooled tube described in this article is identical (from an electrical point of view) with that of the small tubes with which we are now so familiar, their practicability has been made possible only by a new and striking development in the art of sealing metal to glass. In the case of the 100 K. W. tube the seal between the cylindrical copper anode and glass portion is 3.5 inches in diameter.

The remarkable character of these copper-in-glass seals is evidenced by the fact that they do not depend upon a substantial equality between the coefficient of expansion of the metal and glass. The development of the copper-in-glass seals was brought about by Mr. W. G. Houskeeper of the Bell System Research Laboratory at the Western Electric Company. Mr. Houskeeper has also invented means for sealing heavy copper wire and strip through glass in such a way that the best vacua can be maintained under wide changes of temperature.
—Editor.

THE widespread adoption of the vacuum tube as the generator of high frequency currents in low power installations has been brought about by just two factors.

One is the development of radio telephony.

The other is the use of continuous wave transmission in radio telegraphy.

The ordinary form of vacuum tube is, however, ill suited for the handling of large amounts of power, and at the large radio stations, where the plant is rated in hundreds of kilowatts, either the arc or the high frequency alternator is used.

The undoubted advantages to be derived from the use of vacuum tubes (especially in the field of radio telephony where the output power must be modulated to conform to the intricate vibration pattern of the voice), has led to a demand for tubes capable of handling amounts of power comparable with those in use at the largest stations.

That the development of such tubes was of great importance was recognized by the engineers of the Bell Telephone System in the early days of the vacuum tube art. The experiments at Arlington, Virginia, in which speech was first transmitted across the Atlantic to Paris and across the Pacific to Honolulu, required the use of nearly 300 of the most powerful tubes then available, each capable of handling about 25 watts, and the difficulties encountered in operating so many tubes in parallel gave added impetus to the development of high power units.

The usual type of vacuum tube consists of an evacuated glass vessel in which are enclosed three elements: the filament, the plate, and the grid. When the tube is in operation an electron current flows between the filament, which is heated by an auxiliary source of power, and the plate, the magnitude of this current being controlled by the grid.

The passage of the current through a thermionic tube is accompanied by the dissipation in the plate of an amount of power which is comparable to the power delivered to the output circuit and which manifests itself in the form of heat. This causes the temperature of the plate in the usual type of tube to rise until the rate of loss of heat by radiation is equal to the power dissipated. Some of the heat liberated by the plate is absorbed by the walls of the containing vessel, which consequently rise in temperature. These factors, together with a consideration of the size of plate that can be conveniently suspended inside a glass bulb, and the size of glass bulb that can be conveniently worked, set a limit of about 1 to 2 K. W. for the power that can be dissipated in the plate of a commercial vacuum tube of this type.

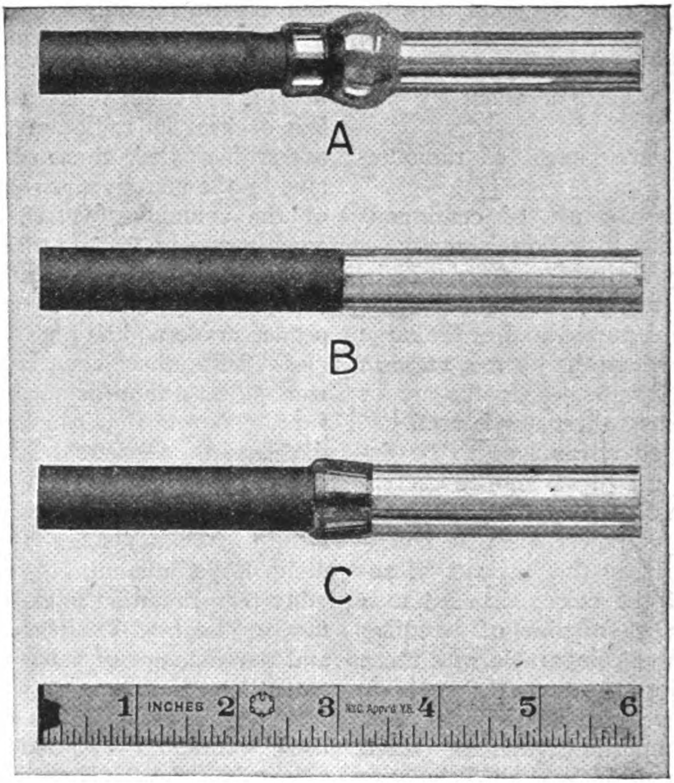
It is apparent then that in the development of vacuum tubes capable of handling large amounts of power, means other than radiation must be used for removing the heat dissipated at the plate, and development of tubes has proceeded along these lines.

A step in the direction of overcoming these limitations was made by Messrs. Schwerin and Weinhart, who were working with Dr. O. E. Buckley on the problem, and who suggested that the anode might be made in the form of a tube or thimble of platinum sealed into a glass vessel and kept cool by passing water through it.

As soon as the pressure of work more directly connected with the necessities of the war would permit, Mr. W. G. Houskeeper and Dr. M. J. Kelly undertook the improvement of the water-cooled tube.

Mr. Houskeeper adapted into the construction of the tube a remarkable type of vacuum seal which he had previously developed. These seals are made between glass and metal and can be made in any desired size. They are capable of withstanding repeated heating and cooling over wide ranges of temperature, from that of liquid air to 350° C., without cracking and without impairment of their vacuum holding properties.

It is no exaggeration to say that the invention of these seals has made possible



THESE THREE JOINTS MAKE THE GIANT TUBE POSSIBLE

Three types of the "tube seal," A, B and C, that are used for producing the air-tight joints between the glass and the metal of the monster tubes.

the construction of vacuum tubes that are capable of handling, in single units, powers of any magnitude which may be called for in radio telegraph and telephone transmission.

The underlying principle connected with the making of this seal consists in obtaining an intimate connection between the glass and metal, either by chemical combination or by mere welding and in so proportioning the glass and metal portions of the seal that the stresses produced when the seal is heated or cooled will not be great enough to rupture either the glass or the junction between the glass and metal.

The three principal types of seals developed by Mr. Houskeeper are known as the ribbon seal, the disc seal and the tube seal.

The type of seal which is the most important in connection with the present problem is the tube seal shown in the illustration on this page. This furnishes the means of joining metal and glass tubes end to end, and is used in the water-cooled tube to attach the anode to the glass cylinder which serves to insulate the other tube elements. As in the case of the disc seal, it can be made either with the edge of the metal not in contact with the glass, as shown at A, or with the metal sharpened to a fine edge which is in contact with the glass. The glass may be situated either inside or outside of the metal (see B and C.)

The first thermionic tubes in which these seals were embodied were made of copper and were designed to operate at 10,000 volts and to give 5 K. W. output.

Although successful from the standpoint of operation, this tube had several undesirable features that it was thought well to eliminate. In the first place the welding of the end into the tube was not particularly desirable, and in general any troubles that occurred due to leaks in the metal could be traced to this point. It was, therefore, decided to go to a type of tube in which the anode would be drawn in one piece and in which as many welds as possible would be eliminated in the assembly of the internal elements. At the same time it was considered desirable to go to a somewhat larger type of structure in which high tension insulation could be more easily provided, and a larger tube was therefore designed capable of delivering 10 K. W. to an antenna at a plate voltage of 10,000 volts.

The final form adopted for this tube is shown on page 219.

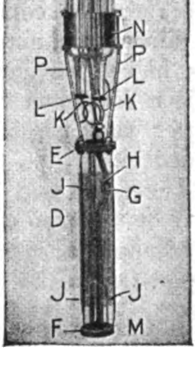
The success which had attended the development of a tube of this high power capacity indicated the possibility of constructing still larger tubes, and it was decided to proceed with the development of a tube capable of delivering at least 100 K. W. into an antenna. The development proceeded with a few minor alterations along the lines of the smaller tube, nominally rated at 10 K. W., and the 100 K. W. tube as now developed is shown in the frontispiece of this magazine. The anode, which is made of a piece of seamless copper tubing closed by a copper disc welded into the end, is 14 inches long and 3.5 inches in diameter. The filament is of tungsten and is .060 inch in diameter and 63.5 inches long. The current required to heat it is 91 amperes, and the power consumed in it 6 K. W. The filament leads are of copper rod one-eighth of an inch in diameter and are sealed through 1-inch copper disc seals. The grid is of molybdenum and is wound around three molybdenum supports.

The handling of the parts of this tube during manufacture presents a task of no mean magnitude, and numerous fixtures have been devised to assist in the glass working. It has been found necessary, for instance, to suspend the anode in gimbals during the making of the tube seal, owing to its great weight, and special devices have been made to hold the filament grid assembly in place while it is being sealed in, otherwise the strains produced by its weight cause cracking.

The significance of this development in the radio art cannot be overestimated. It makes available tubes in units so large that only a very few would be necessary to operate even the largest radio stations now extant, with all the attendant flexibility of operation which accompanies the use of the vacuum tube.

From the standpoint of radio telephony the development of these high-power tubes gives us the possibility of using very much greater amounts of power than have ever been readily available before. The filaments in these tubes have been made so large that the electron emission from them will easily take care of the high peak currents accompanying the transmission of modulated power.

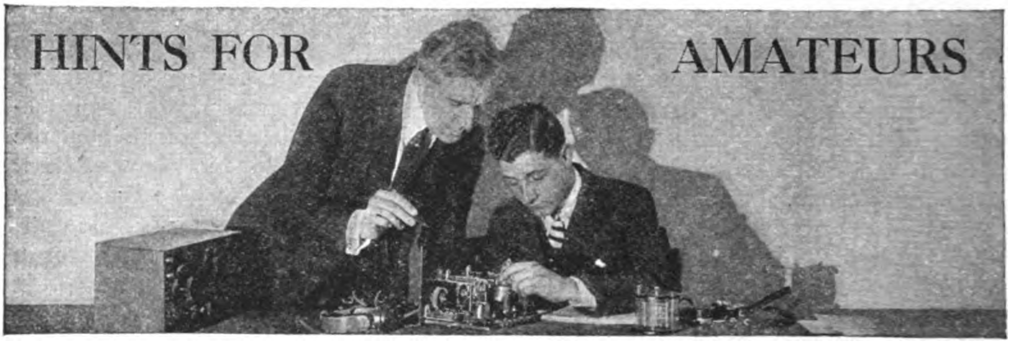
The 100 K. W. tube by no means represents the largest tube made possible by the present development. There is no doubt that if the demand should occur for tubes capable of handling much larger amounts of power they could be constructed along these same lines.



HOW IT IS BUILT

The grid assembly is shown at D, and is supported by the rods M and the lavite blocks E and F. The filament is of tungsten and is connected to the two molybdenum rods G and H, which are coiled into single turn spirals at KK and led through the glass by the disc seals LL. The hooks J hold the lower end of the filament in position. The whole structure is mounted on the flare R by means of the nickel collar N and the supports P. The grid lead is brought out through the glass tube Q.

HINTS FOR AMATEURS



It is often a great help in tuning to have the antenna circuit of a receiving set tuned by a variable condenser, especially when the condenser can be placed in series with the circuit or in parallel. In order to make this system of the utmost convenience it is necessary to use some sort of switching arrangement that will allow the operator to make a quick change, so that time is not wasted in changing connections to the condenser.

A suitable method for doing this has always been a little too much for the novice in radio, probably because he thought it too complicated.

For the amateur who has his apparatus mounted on a board, a double pole, double throw knife switch will be suitable. It should be connected as shown in Figure 1, with the primary coil across the two contacts at one end of the switch, the condenser connected across the switch blades, and the antenna and ground leads connected on opposite sides of the switch, as shown in the diagram. The change-over lead should run from the bottom right-hand contact to the top left-hand contact. When the switch is thrown to the right the condenser is connected in parallel to the antenna circuit (tuning to the higher wavelengths); thrown to the left it is connected in series, when the lower wavelengths will be more easily tuned in.

There are two styles of switches that may be mounted on the panel and make a good appearance as well as work satisfactorily. One of them is the rotary change-over switch with two double ended switch arms and eight contact points (as shown in Figure 2). The other style is a panel-mounted anti-capacity snap switch with a small button protruding through the panel. This switch is shown in Figure 3, hooked up to an antenna circuit. A change-over switch is not necessary in the secondary circuit of a receiver.

* * *

A variometer is a very hard piece of apparatus for the amateur to construct himself, because of the fact that the stator winding must fit very closely to the rotor winding when the instrument is assembled. This necessitates special form-wound coils for the stator and a difficult method of transferring the windings from the forms to the blocks to which the winding is finally fitted.

There are many types of manufactured variometers which are suitable for amateur use and which are so reasonable in price that it is foolish for the amateur to think that he is saving either money or time, when he tries to make his own. After much planning, worrying and patience-testing labor he has an instrument that he calls a variometer, but it usually is an inferior instrument.

* * *

When experimenting with the new super-regenerative receiver the amateur is cautioned not to get discouraged until he has played with the set for a week or so and understands the principles of its operation. It is imperative that hard tubes be used and they should be shifted around until the best tube is found for the regenerator and the best one for the oscillator. Upon such seemingly unimportant details is success based.

* * *

A LOOP antenna is not much of a success where a crystal detector is used alone in a receiving set. The results will be practically nil.

* * *

MANY novices confuse the wavelength of a transmitted signal with the distance the signal can be sent. Thus, some questions have been sent in to the "What Readers Ask" department, asking the wavelength from New York to Chicago, or the question "Will I be able to receive from a greater distance if I put in a loading coil?" This is a mistaken notion. The wavelength of a signal refers indirectly to its frequency or number of cycles a second, just as the pitch of a musical note refers to the frequency of the note or the number of impulses a second necessary to produce it, and not the distance it will travel.

* * *

Do not let your storage batteries run down dead, as this misuse will soon cause deterioration and the battery will be no good. When your battery shows signs of dropping, take it to the garage and get it recharged. Better yet, obtain a charging device and keep it always charged yourself by turning on the charger after you have used the set. The charging device will quickly pay for itself, as the battery lasts longer and you will save the money paid to the garage man for charging. A charger is a good investment at any time.

* * *

A HANDY kink for the radio experimenter to use is ready-made "leads" or insulated wires with small spring clips at each end. These may be made in varying lengths, so that when (during an experiment with a new circuit) he wishes to try some other connections, he need merely unclip the wires and reclip them in the new positions without the bother of cutting new leads, scraping the wires clean and fastening them in the binding posts. The new way is a time saver and much more convenient. Make

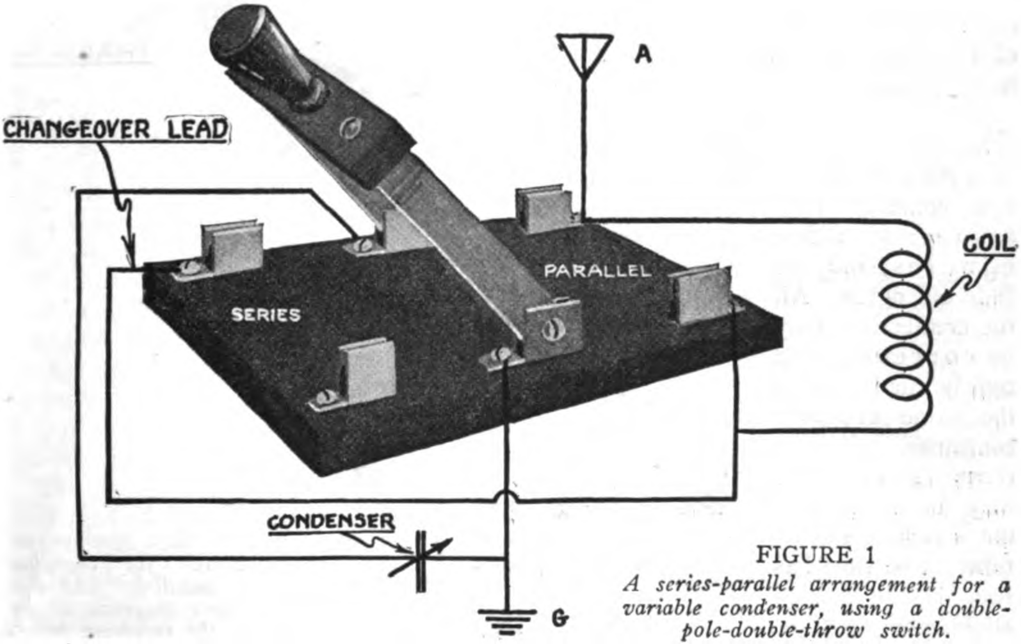


FIGURE 1
A series-parallel arrangement for a variable condenser, using a double-pole-double-throw switch.

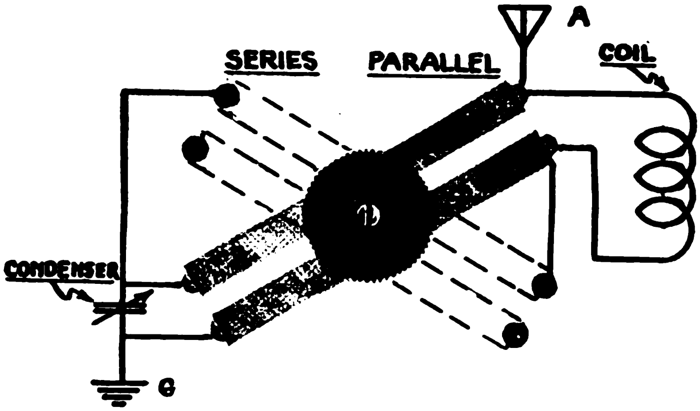


FIGURE 2
The same circuit as shown in Figure 1, except that a rotary panel switch is used.

up some testing leads and take the drudgery out of your experimentation.

* * *

An "A" battery is usually a storage battery of 6 volts and is used to heat the filaments of the vacuum tubes in the receiving set. A "B" battery is composed of a number of small flashlight dry batteries connected in series and are usually made up in blocks having 22½ volts a block. The "B" battery is used to make the plate of a vacuum tube sufficiently positive with respect to the filament to facilitate the passage of electrons across from the filament to the plate.

* * *

Sometimes the amateur has trouble with his receiving set, in that the signals come in loud and clear for a few minutes, only to fade out again. All the connections may be correctly and tightly made, still the same trouble continues. Sometimes this trouble may be located in the socket of the tube. The tube has four little prongs sticking out from the bottom of the base; on the end of each of these is a little drop of solder. This is supposed to make contact with the strips in the socket, but often the little dabs of solder get blackened and dirty and a poor contact is obtained.

This trouble may be easily remedied by polishing the bottom of each of the four little prongs with a piece of smooth sandpaper.

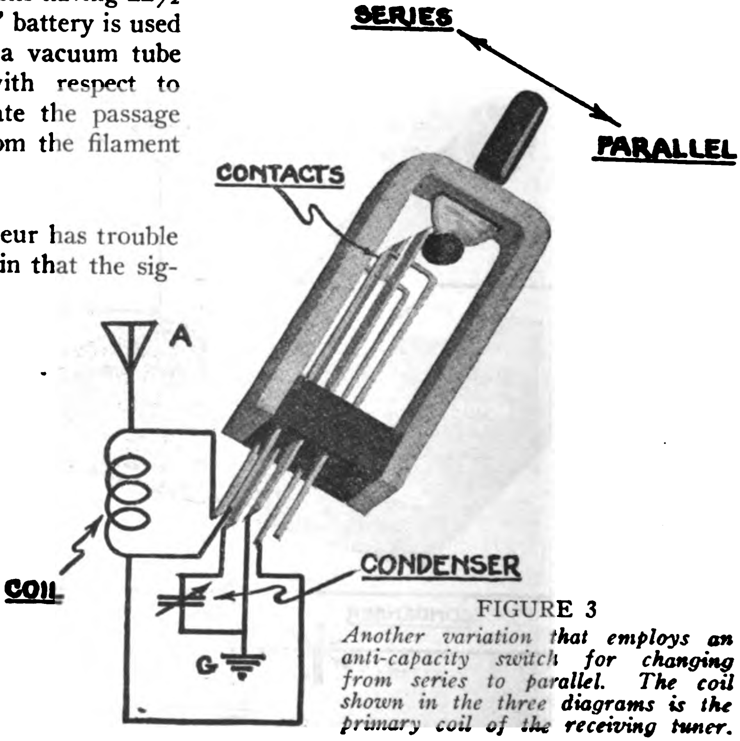


FIGURE 3
Another variation that employs an anti-capacity switch for changing from series to parallel. The coil shown in the three diagrams is the primary coil of the receiving tuner.

LISTENING IN

Help *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

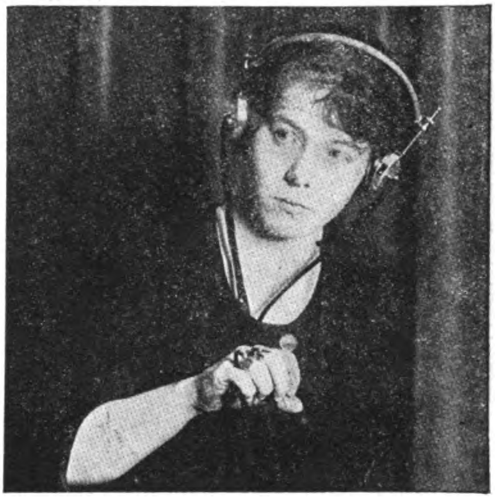
A New Test for Amateurs

FOR the first time in the history of amateur radio American and Canadian amateurs will have an opportunity to demonstrate their skill in receiving amateur signals from across the Atlantic.

The third series of transatlantic amateur tests will be conducted by the American Radio Relay League, in co-operation with the radio amateurs of England, France and Holland, from December 12 to December 31, 1922, inclusive. During the first ten days of the tests American and Canadian amateurs will transmit signals for reception by the radio amateurs of the European countries. Those of the American and Canadian transmitters who make the best records (as determined by reception reports from the European amateurs) will be used to transmit the results of reception by American and Canadian radio amateurs when the English and French amateurs send.

A series of preliminary tests, for the purpose of determining which American and Canadian transmitters shall be given a place in the final tests with an individual schedule and code letters, will be conducted from October 25 to November 3, inclusive. To qualify for the final tests a transmitter must cover at least 1,200 air-line miles during the preliminary tests.

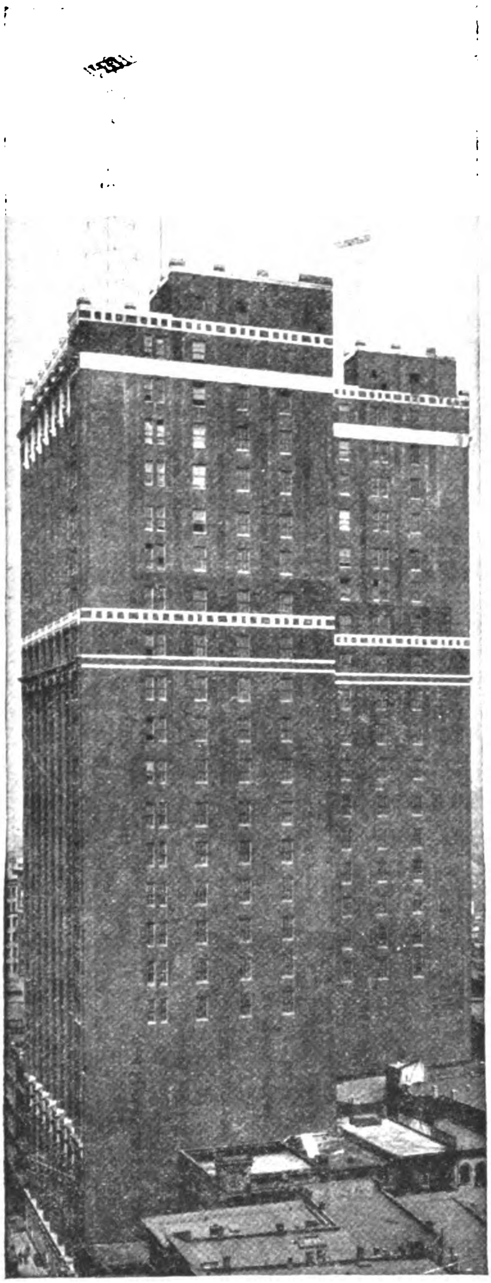
The preliminary tests will cover a period of two and one-half hours (9:30 P.M. to midnight, Central Standard Time) each night; this period will be subdivided into ten periods of fifteen minutes each. Transmission will take place by inspection districts. One district will transmit at a time, and all others will remain silent during the attempt to copy as many of the transmitting stations as possible. After the tests each night the receiving stations will send a confirming record to all transmitters at a distance of 1,200 air-line miles or over. When filing application for entry in the final tests, a transmitter must show documentary evidence that his signals have reached out 1,200 air-line miles during the months of September or October.



Pacific & Atlantic

A FINGER-RING RECEIVER

This is claimed to be the smallest set made. Do our readers know of one smaller?



A PAY-AS-YOU-ENTER STATION

To meet the demand for a broadcasting toll station—a station that can be hired for occasions—the American Telephone and Telegraph Co. has established WBAY atop this conspicuous building in New York. The antenna towers are 488 feet above the sidewalk, and are built to withstand a wind load of 5,000 pounds. The result of this unique experiment is being watched with more than casual interest.

Radio Fans to Pay Tribute to John Bull

HOW John Bull is treating the radio amateur in England—where radio has not yet taken hold in anything like the way it has on this side of the ocean—is revealed in the interesting comment of Mr. A. P. M. Fleming, a prominent English engineer, who recently visited some of our large broadcasting stations:

At present we have no such thing as broadcasting in Britain in the sense in which the term is used in America. Government restrictions have prevented it on account of the possible interference with the requirements of the navy, mercantile marine, war services, and aeroplane traffic. But the largest manufacturers of radio apparatus have co-operated with the British Government officials in working out plans for the control of broadcasting.

We have learned many valuable lessons from the broadcasting experience of the United States. One of them is to avoid the establishment of innumerable radio stations, with no plan of cooperation between them. Eight 1½ K.W. stations are contemplated and some of these will probably be built shortly. These stations will be located in the principal cities throughout the British Isles and will be operated so as to eliminate the chaos usually found where no rules are in force.

The broadcasting stations will be operated on strictly regulated wavelengths and other set rules, which will be published for the guidance of radio receiver owners. Every radio set owner will be required to pay an annual tax, also, and there will doubtless be special restrictions applying in times of national emergency.

* * *

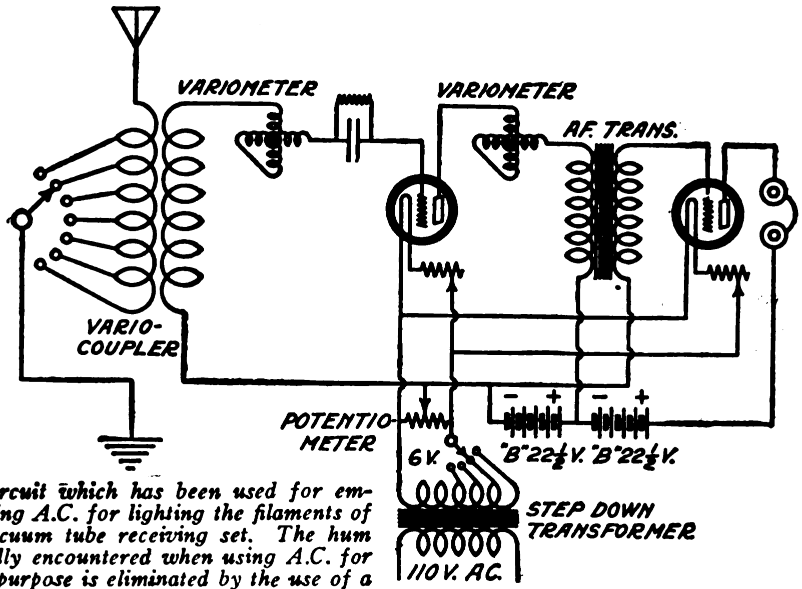
A Toy Step-Down Transformer in a Receiving Set

IF you receive an electrically operated toy railroad train from Santa Claus, you may adapt a part of it for a novel use on your radio set, as this experimenter did:

I am using a toy transformer on my apparatus with great success. I get very little hum when the set is properly tuned, due to the fact that I use a potentiometer across the transformer, with the "B" battery negative pole connected to the switch arm, as shown in the accompanying diagram. The transformer is especially successful when using the loud-speaker, as the hum carries only a few feet while the signals may be heard all over the room. I am using a regenerative circuit with one stage of audio frequency amplification.*

A. Thomas Wells

**See circuit diagram on page 223.*



A circuit which has been used for employing A.C. for lighting the filaments of a vacuum tube receiving set. The hum usually encountered when using A.C. for this purpose is eliminated by the use of a potentiometer for the connections to the grids of the tubes.

The New "Class B" Stations

A DISTINCT step forward in the broadcasting problem has just been taken by the Washington authorities through the Secretary of Commerce, Herbert Hoover. A new "Class B" station has been created that shall have special wave-length assignments and that shall be specifically charged with the maintenance of high-grade programs—not unlike the special "red seal" records of the gramophone. The next step in the development of the plan will be to maintain these programs at the highest possible level; on this point, indeed, POPULAR RADIO has been quietly working for several weeks; the results will be published in a subsequent issue. Secretary Hoover's announcement reads as follows:

A new class of radio telephone broadcasting station license is hereby established, to be known as Class "B." A license will not be issued for a station in this class which does not comply in every respect with the specifications hereunder.

Specifications covering the requirements governing the construction, licensing, operating and service of Class "B" radio telephone broadcasting stations:

Wavelength—The wavelength of 400 meters only will be assigned for the use of stations of this class, which must be reasonably free from harmonics.

Power—The power supply must be dependable and nonfluctuating. The minimum required will be 500 watts in the antenna and the maximum shall not exceed 1,000 watts in the antenna.

Modulation—The system must be so arranged as to cause the generated radio frequency current to vary accurately according to the sound impressed upon the microphone system.

Spare Parts—Sufficient tubes and other material must be readily available to insure continuity and reliability of the announced schedule of service.

Antenna—The antenna must be so constructed as to prevent swinging.

Signaling System—Some dependable system must be provided for communication between the operating room and the studio.

Studio—The radio equipment in the studio must be limited to that essential for use in the room. The room shall be so arranged as to avoid sound reverberation and to exclude external and unnecessary noises.

Programs—The programs must be carefully supervised and maintained to insure satisfactory service to the public.

Music—Mechanically operated musical instruments may be used only in an emergency and during intermission periods in regular program.

Division of Time—Where two or more stations of Class "B" are licensed in the same city or locality a division of time will be required if necessary.

Licenses issued for the use of the 400 meters wavelength shall specifically provide that any failure to maintain the standards prescribed for such stations may result in the cancellation of the license and requiring the station to use the 360 meters wavelength.

A Fly-Screen for an Aerial

HERE are some practical ideas with which the radio novice may like to experiment; all of them presage the ultimate passing of the expensive and troublesome outdoor aerial that still leads all other types in efficiency:

A standard aerial, while productive of the best results in radio reception, is not always necessary; there are many substitutes. Those radio fans who have no place to install the regulation type may receive by any one of the following means if long distance work is not contemplated.

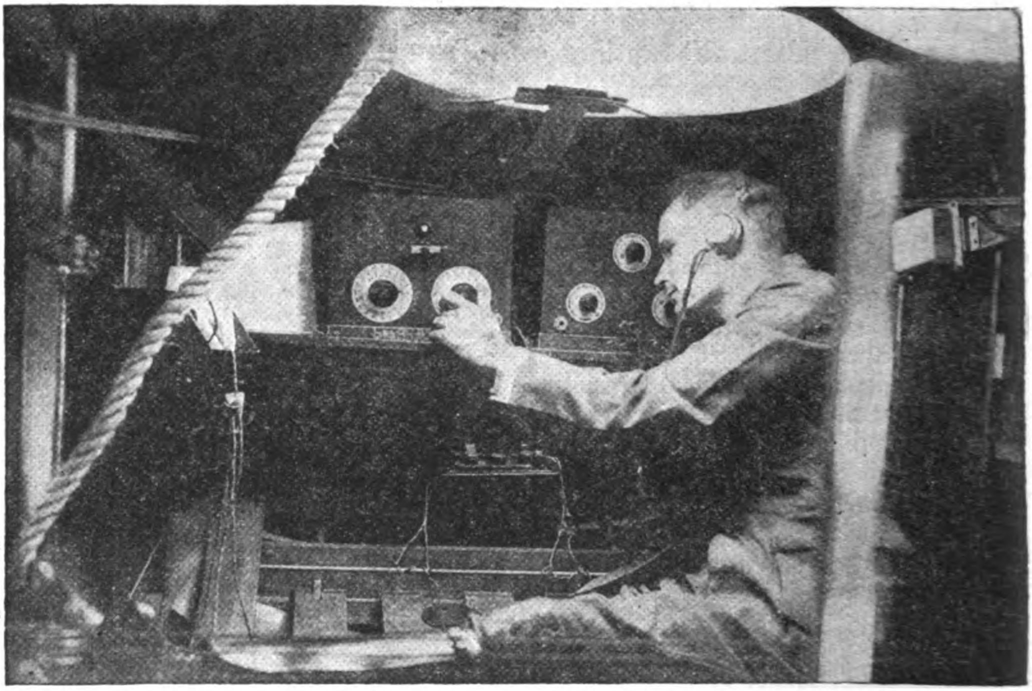
A metal porch screen will often play the part of an aerial. If the screen is in sections, try each section separately; then try connecting two or three or all of them together. I find that the section parallel with the house will receive some stations well, but it will not get others at all;* sometimes the screen at right angles to the house will get signals that the other screens will not; hence it would be well to do a little experimenting.

The wires used in houses equipped with electric bells may also serve as aerials. If you try this it is well to go over the wires and see that they are not grounded; if they are, you are doomed to disappointment. Whenever the wire touches a radiator, gas pipe or water pipe, either take it away or insert a piece of rubber or other insulating material between the wire and the metal. Fairly good signals may ordinarily be obtained this way.

Another makeshift that has sometimes proved useful is the telephone. Merely connect a wire from the aerial terminal of the radio to a metal part of the telephone (not to the telephone wires or binding posts) and then tune in. Excellent results are sometimes produced by this method, if the telephone wires are brought to the house from an outside pole—but underground wires do not always work as well.

LeRoy Whitman

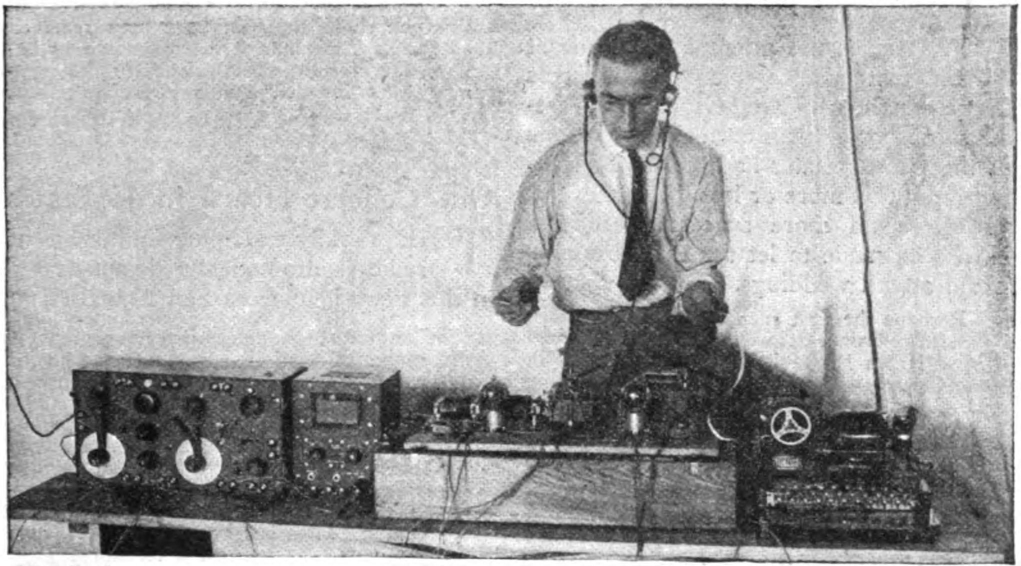
**This is due to the directional effects of the vertical screens.*



Radio Corporation of America

A LISTENING-IN POST AMONG THE CLOUDS

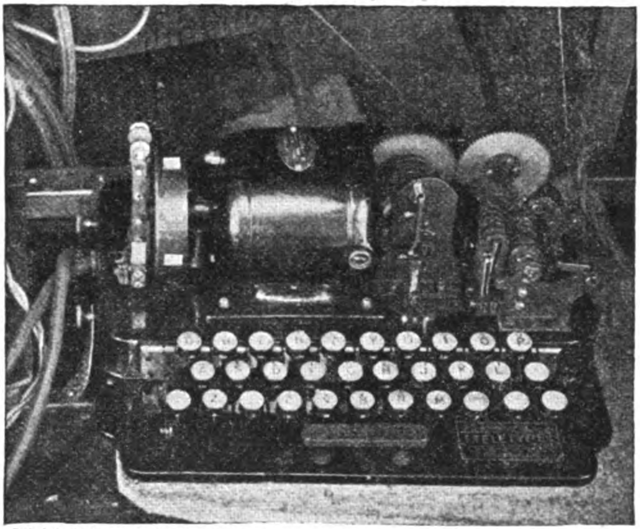
How modern science is slowly but surely reducing time and space was aptly illustrated by the inter-continental flight of the seaplane "Sampaio Correia," which left New York August 16th for its eventful effort to reach Brazil. It was equipped with a radio receiving set with a range of 500 miles, which enabled Lieut. Walter Hinton, the pilot, to keep in communication with shore stations and vessels—not only for the purpose of receiving weather reports, but even for purposes of entertainment. It was entirely possible for the adventurers in the sky to hear the New York Philharmonic concert the evening they set forth!



International

A Ghostly Hand on the Keyboard

ONE of the chief difficulties in communicating by radio between airplanes in flight, or between land stations and airplanes in flight, has been to overcome the great noise of the engines sufficiently to enable the operators to hear the signals. Recent experiments at the Anacostia Naval Air Station, near Washington, D. C., would indicate that this problem is being solved at last by the "teletype"—a typewriting machine that is operated from a distance by radio. The instrument employed is the type familiar in commercial work; it consists of sending and receiving parts. The sending instrument (which may be mounted in a standard type of Navy plane) resembles in general the commercial typewriter that is equipped with keyboard letters and other conventional symbols operated by hand. Each key is connected with the radio installation of the transmitting set; when a letter is struck on the keyboard a radio impulse is sent out from the antenna of the plane and is recorded in the similar key at the receiving instrument. The transmitter is shown at the top of this page, and the teletype—which types the radio message before the pilot's eyes—is shown in the smaller cut.



Official photograph, U. S. Navy

THE TELETYPE ON AN AIRPLANE

In order to insure the proper transmission of radio messages to naval planes in flight, successful experiments have been made in typing the signals, thus overcoming the difficulties of receiving the messages by ear.

Married by Radio

EVER since the attempt to broadcast the marriage ceremony of Princess Mary, daughter of King George, in Westminster Abbey, when even the radio fans of the United States had hopes of listening-in on this more or less historic event, various (and more successful) efforts have been made to let the eavesdropping world attend weddings. For instance:

Perhaps the first such ceremony ever successfully broadcast was that which united Miss Helen B. Cook to John H. Collier in the Church of the Covenant at Washington, D. C., on September the sixth. Listeners-in were given plenty of time to tune in sharply, for the ceremony was announced long in advance, and the wedding march was played as an overture. From an advantageous position the words of the minister, the Rev. John C. Palmer, as well as the troths of the couple, were caught by the acousticon.

Sermons which have been broadcast from this church in the past have been received as far as Alabama; it is reasonable to believe, therefore, that the privacy of the ceremony was "invaded" by many receiving fans.

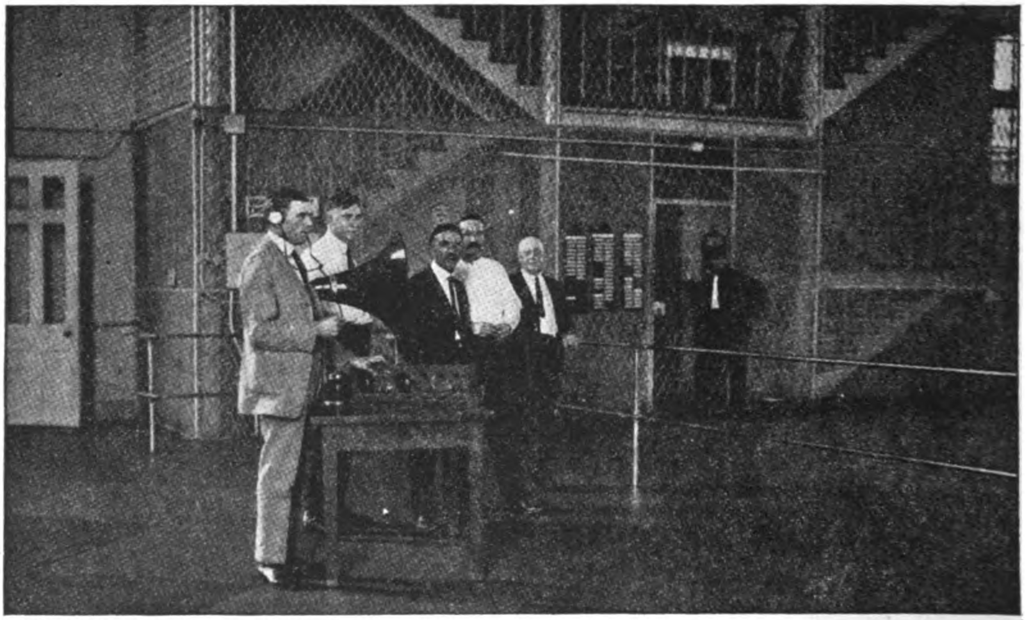
LEROY WHITMAN

* * *

One Concert Heard in 48 States

THE rapidly extending influence of radio is dramatically demonstrated in this news item from San Francisco:

In an effort to determine how great is the range of station KSD, a program of music by exceptional talent was given Sept. 12th between 11 P. M. and 1:27 A. M. A flood of telegrams which followed gave complete proof that the broadcasting test was heard in every one of the forty-eight states in the Union. So far as can be ascertained, no other broadcasting station in the United States has ever been heard, in a single night, over so vast a territory.

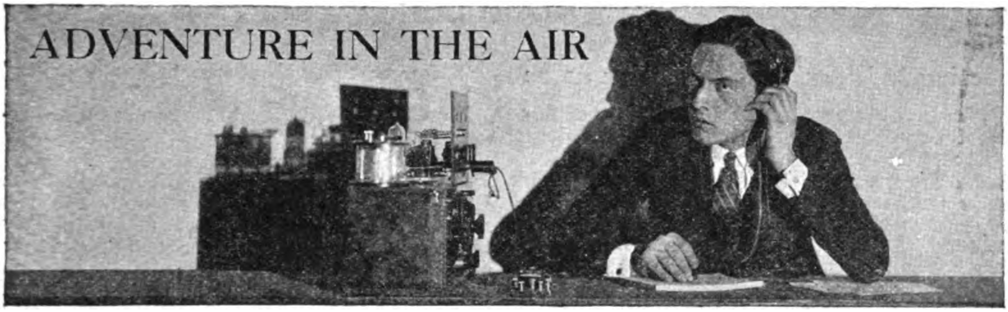


© Harris & Ewing

RADIO IS PUT IN JAIL AT LAST!

To be apprehended by means of radio and then to be entertained by it in jail is the ironical outlook for lawbreakers in Washington, D. C. The inmates there may stretch themselves out on their prison cots and listen to the stirring strains of the United States Navy Band, the daily police reports on stolen automobiles, and perhaps they may even speculate on the ease with which the radio waves penetrate the stone walls of their prison. A loop aerial is used to catch the waves for the receiving set. After using ear phones to tune in, the operator switches the programs on to a loud-speaker placed in the rotunda of the jail; by this means the inmates in the distant cells hear the entertainment plainly. Often, however, Captain W. L. Peak allows the three hundred and twenty men to leave their cells and come down to the auditorium.

ADVENTURE IN THE AIR



WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote; humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East 40th Street, New York City.*

A Real Prince Springs a Surprise Party

ONLY a few of the radio fans today will recall the following episode—and those few may well be called the "Old Timers" of radio:

Long before the advent of the present popular radio telephone, back in the days when the only radio amateurs were the chaps who mastered the International Morse code, and little dreamed of ever being able to hear anything over the radio waves except the dots and dashes that spelled out the messages letter by letter, a mysterious steam yacht glided slowly one night into New York harbor, up past the skyscrapers of Manhattan to an anchorage up in the Hudson River opposite Riverside Drive, where she dropped anchor and hoisted her riding light.

No shore-going party left her side in the little gasoline tender. Her distinguished owner had business aboard that night; he had a little surprise to spring upon America—a surprise which no one but a man of much wealth could afford to spring. It had taken time and money and plenty of genius and imagination to prepare this surprise party.

I was listening in myself that night. Soon I and my fellow amateurs were listening to something I had never before heard—music by radio telegraph!

First came the "Star-Spangled Banner"; then "Yankee Doodle," followed by the "Blue Danube Waltz" and other selections. The word spread like wild-fire. Station called station and passed the word, "Listen in for the music on 550 meters." Ships at sea heard it, stations up and down the coast and the amateur stations back inland were getting it. Whence came the music and how was it played?

It was not until twenty-four hours later, when the press announced the arrival of the Prince of Monaco on his yacht the *Hirondel* and told of his marvelous new "wireless invention," that anyone knew.

The visitor was none other than the Prince himself. He had voyaged all the way to America from his palace on the shores of the Mediterranean for the express purpose of springing his surprise on America.

How did he do it? It was a clever arrangement. Anyone who has ever listened in to the radio stations transmitting messages by the spark system will recall that each station has its characteristic note, the musical pitch of which is governed by the adjustment of the apparatus in use. The Prince had arranged his radio transmitter with a set of piano keys so that each individual key, when depressed, would transmit a spark signal at a certain adjustment for pitch; by properly adjusting the device for frequency and pitch he had produced a complete musical scale, and it was then only necessary for him to play the instrument just as one plays a piano. For variety, he would pause now and then on one particular note, and by depressing and releasing that key at intervals he transmitted a few words of jest in code, after which he would continue the air he had started to play.

When the Prince up-anchored and sailed away he did so with the satisfaction of having accomplished his mission.

E. JAY QUINBY.

My Apparatus Fails at a Critical Moment

HERE is a real case of "take it or leave it." It comes from a radio operator on a vessel whose captain literally had to decide whether to rescue the crew of a burning freighter, or to let George do it:

Six days out from Bishop's Rock, bound for Norfolk, and fighting a nor'wester, I picked up an SOS from a British freighter. It was late in the afternoon and I had been working a few ships that day, principally exchanging position reports, so I knew that we were the closest one to him. As it generally happens, my circuit breaker kicked out when I tried to start the motor generator and another ship, four hundred miles away, answered ahead of me.

We were just one hundred miles off the Britisher, and I got the other operator who answered the call to stand by. The freighter was afire in three hatches and burning rapidly; the water from the fire hose was entering the radio shack and putting the apparatus out of commission occasionally, so communication was poor and, to add to the difficulties, I had a hard time keeping the rest of the ships in the vicinity quiet. Finally conditions improved and I learned that there was no immediate danger; the freighter wanted a ship to come alongside and stand by until the fire was put out, or take the crew off if such action became necessary.

Our captain informed the Britisher that we could take the crew off as soon as we arrived, but could not stand by, for we were running short of fuel, and could not afford to lose much time. The Britisher then told us to proceed on our course, and the ship that answered the distress call first went to his assistance and stood by for two days before the fire was under control.

JOSEPH H. O'CONNOR

I Become a Radio Expert in a Week

ONE of the engaging features of radio —the one feature, indeed, that is most responsible for its universal appeal —is the fact that for a few dollars anyone can enter the new world of the ether. Radio is not for the exclusive few. And just to prove how simple and inexpensive it is for even an inexperienced novice to make a set at home, the "Boss" of one of the important newspapers of this country told one of his staff, a young woman just out of college, to build one and tell what happened. This is her story—as told in a personal letter to the Editor:

The Boss came to me and asked:

"Know anything about radio?"

"No."

"Know anything about how to handle tools?"

"No."

"Well then go ahead and make a radio receiving set."

Just like that!

It developed that the big idea was that the Boss wanted to prove that a simple but first-class radio receiving set could be built by anybody regardless of his or her knowledge of radio or mechanics in general. Evidently he sized me up up as the dumbest individual in that line in the office, so I was elected to be the goat. I was to build a working set and then write a series of articles telling in absolute detail how to do the thing.

We will draw a veil over what followed, as the story-books say. Suffice it to say that the set was built. And what is more, it worked. Not only that but it worked well, very well—doggone well, I should say in the language of my gang. Nobody was more surprised than I, when following a week's work, after I had managed to do everything at least one wrong way before getting it right, after I had covered myself with mahogany varnish and copper stain, after I had pounded my fingers and wound myself up in coils of wire, and after I had gone dizzy figuring out positions, I set the thing up, tuned in—and a perfectly good concert came pouring in over the phones!

Then I wrote twelve columns of "How," and told my prospective readers just how to bore a hole, put in a screw, and especially how *not* to do the things I did. The staff photographer came out, took some pictures that looked as if I was doing something with the set, and then we started the series of articles in the paper.

Then came along the radio show. And since my paper had made so much of its radio column (being the first paper to have one, and all that), we decided to have a booth. Among other attractions were to be Nancy and the set, both on exhibition. Nancy was to be there for the purpose of answering questions and proving that she and the set were both practical actualities. So we got out several thousand pamphlets that contained reprints of the first few chapters in the series and advising: "Read the rest in the—."

The crowds apparently liked the booth and apparently they liked Nancy. There was just one single set on the counter—not a lot of technical apparatus. As I found that most people knew even less about radio than I, the demonstrations registered strong.

It was good fun the first forty-eight hours. After that I could say; "It has a radius of 30 miles;" "Yes, it could be made for $15," in my sleep.

But the set and I went over with a bang, so after all, it didn't make much difference that I hadn't the courage to look an aerial in the face for a month after.

NANCY

¶ *So many inquiries have been received concerning the instruction in radio work that is being offered by the State Militia—instruction for which the student is paid—that* POPULAR RADIO *will shortly publish a sequel to "What the National Guardsman Is Doing with Radio" in the form of an article that will describe what the naval militiaman is doing with it—and he is doing a lot.*

JUN 25 1927

Vol 2 2-4

Popular Radio

DECEMBER,
1922

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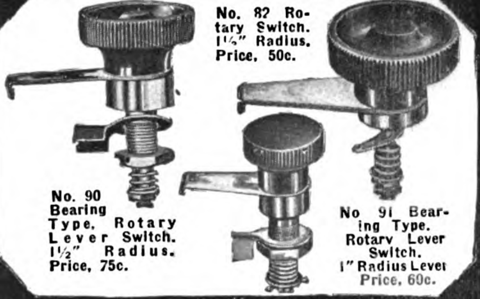
REMLER

Cunningham

APPARATUS THAT RADIATES QUALITY



No. 82 Rotary Switch. 1½" Radius. Price, 50c.

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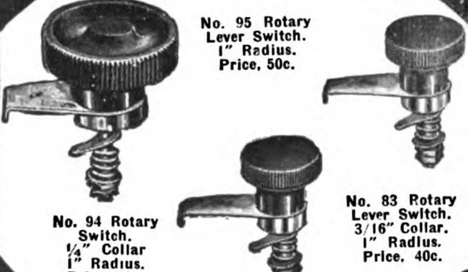
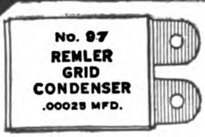
No 91 Bearing Type. Rotary Lever Switch. 1" Radius Lever Price, 60c.



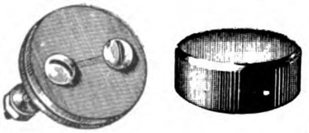
No. 95 Rotary Lever Switch. 1" Radius. Price, 50c.

No. 94 Rotary Switch. ¼" Collar 1" Radius. Price. 40c.

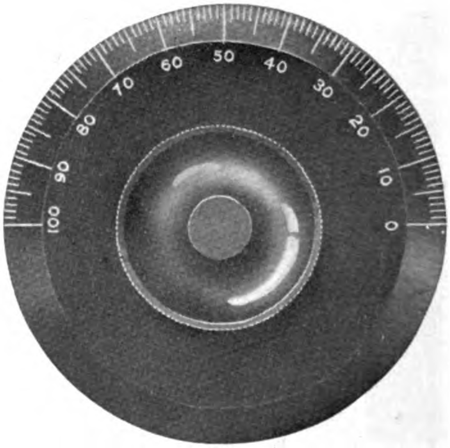
No. 83 Rotary Lever Switch. 3/16" Collar. 1" Radius. Price. 40c.



No. 97 Fixed Grid Condenser. Price, 20c.



No. 96 Variable Grid Leak. Price, 40c.



Type No. 100
3-inch Bakelite Dial with Knob and Bushing 75c

Remler Parts For Your Set

On this page are shown the popular line of Remler switches, the Remler Fixed Grid Condenser, the Remler Variable Grid Leak and the famous Remler Dial.

This represents but a small fraction of the Quality Radio Apparatus that has put Remler in the leading position it holds today.

It is becoming more and more apparent that Remler Apparatus is preferred in the building of sets because of its uniformity of construction—the well balanced proportion of each item giving an accurate and a pleasing appearance to the finished set.

Insist on Remler parts. If your dealer cannot supply you, write us direct for the name of a Radio dealer who can.

NEW REMLER CATALOG

Send 10c for new 40-page Remler Catalog just off the press, containing circuit diagrams for Remler Apparatus and other useful information, including a table of inductance, capacity and wave length.

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WITH YOUR RADIO SET

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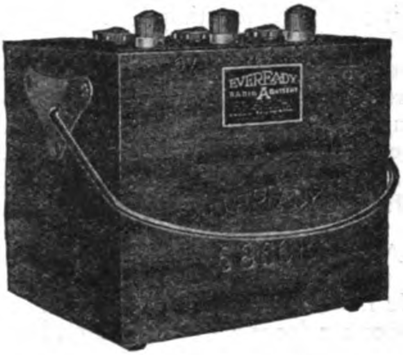
—Hardwood Box, Mahogany Finish
—Convenient Handle, Nickel Plated
—Rubber Feet, Protect the Table

No Accidental Short-Circuits

All Eveready "A" batteries are equipped with a 4 volt as well as a 6 volt terminal, making it possible to use either 6 volt or 4 volt vacuum tubes in your set



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Guaranteed to be Absolutely Noiseless

Columbia Ignitor Six-Inch Dry Cells Equipped with Fahnestock Connectors

Columbia Dry Cells are suitable for the filament or "A" circuit of Westinghouse WD-11 Vacuum Tubes, which require one six-inch dry cell per tube

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POPULAR RADIO

EDITED *by* KENDALL BANNING

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(Cover design by Gerald Leake)

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

"Just scales and full measure, injure no man." The full measure of service goes with every Grebe Receiver"
Doctor Mu.

ANYONE who knows radio will tell you how well the Grebe CR-5 performs on the daily concerts, lectures, etc., in the air.

Two simple tuning adjustments are used. Tiresome adjustments, unpleasant interruptions are unnecessary with the Grebe CR-5. Its range, 150—3000 metres.

Ten years experience in satisfying a critical radio public has taught us how to build it for your year-round enjoyment.

If your Dealer does not sell Grebe Radio Apparatus, send us his name and receive interesting circular.

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A PAGE WITH THE EDITOR

EVERY radio fan knows—or *ought* to know—what the "Heaviside Layer" theory is and how it affects radio waves. If he doesn't, he may turn to page 231 and find out. Dr. Elihu Thomson there states that the theory is invalid, and gives his reasons. In the January issue Sir Oliver Lodge states that the theory is perfectly good, and also gives his reasons.

* * *

THUS another international argument is precipitated!

* * *

THE broadcasting of the side-line reports of the World-Series baseball games at the Polo Grounds in New York—thanks to the timely cooperation of the Western Union Telegraph Company—was not only a treat to hundreds of thousands of radio fans, but also a stimulant to the radio industry as a whole. As this issue of POPULAR RADIO goes to press negotiations are pending for broadcasting side-line reports of the big football games of the East. Only failure to obtain the necessary wires from the athletic fields to the broadcasting stations will prevent the plan from being carried into effect.

* * *

"I AM a crippled soldier and have been in the hospital since December, 1919," writes Cyril A. Newman (Serial No. C—613,886) from the Mercer Hospital at Trenton, N. J. "I won't be able to leave the Government's care for some years. Can you help me get a radio outfit to help pass the time? I haven't any money with which to buy one—but I'm radio crazy."

* * *

THROUGH the generosity of a POPULAR RADIO reader, veteran Newman's request has been granted. But his plea has given the Editor an idea. Why not send discarded radio sets to other invalids in other hospitals?

* * *

RADIO sets forwarded to the office of POPULAR RADIO will be distributed among disabled veterans without charge—and after investigation of each case.

Where could a radio set be located to better advantage than at a cripple's bedside?

* * * *

"WE have been advertising in six of the leading radio papers, and have had our advertisements keyed," writes H. M. Linter of the Teleradio Corporation of New York. "We find that we get two replies from POPULAR RADIO to only one from *all the other five publications combined.*"

* * *

THOSE are strong words, Brother Linter! But you are not alone in your experience with POPULAR RADIO'S advertising pages. Here, for example, is what S. J. GROSSMAN, of the Man-Day Radio Corporation, writes:

"Dollar for dollar, your magazine has brought in returns far better than any other publication—and we advertise only in the best magazines."

* * *

THE letters quoted above are but typical of dozens. They are of peculiar interest to the Editor because they indicate that POPULAR RADIO is actually reaching the class of reader at which it is aiming—the radio novice and the radio amateur.

* * *

EVER since the successful broadcasting of the New York Philharmonic concerts last summer, POPULAR RADIO has been making efforts to arrange for the broadcasting of additional concerts this winter by the same great orchestra. As this number goes to press it appears that this project will be accomplished. Important as this undertaking is in itself, it is but part of a great nation-wide program which this magazine is working—and working hard—to build up for the benefit of radio fans and of the radio industry.

* * *

"YOUR November number," writes Dr. William H. Easton of New York, "contains two remarkable features. One is the first intelligible description of the Relativity Theory, in Sir Oliver Lodge's contribution; the other is the first simple, clear-cut description of the action of a regenerative receiver in John V. Hogan's article."

Our own ideas exactly!

* * *

"I COULD go on for page after page of tribute to POPULAR RADIO and still not say enough," writes Frank Feigle of New Kensington, Pa., at the conclusion of a letter. "We radio old-timers need your magazine as letters need stamps."

The Editor can add only the hope that they will be as inseparable.

* * *

WITH this issue POPULAR RADIO introduces to its readers a new member of the editorial staff—George B. Chadwick, captain of the famous 1903 Yale football team, editor, officer in the World War and for the past three years Director of Publications of the American Red Cross, National Headquarters, Washington, D. C. Mr. Chadwick is taking over the duties of Managing Editor.

Kendall Banning

Editor POPULAR RADIO

From a photograph made for POPULAR RADIO

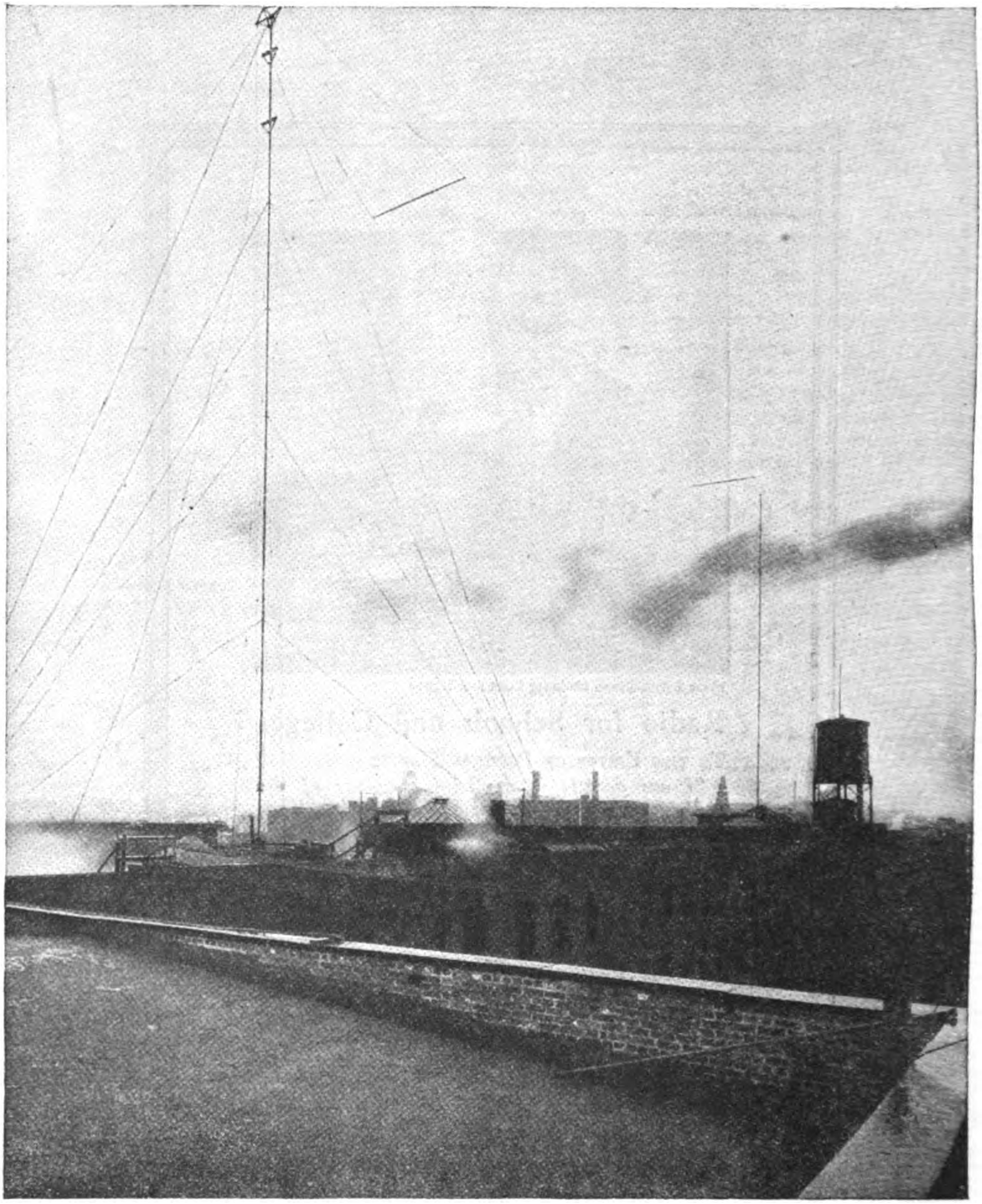
Radio for Schools and Colleges

To THE EDITOR OF POPULAR RADIO:

"I am greatly interested in the use of the radio for educational and cultural purposes. . . . I am hoping that we may be able to do some work of this description shortly."

Jno J. Tigert

COMMISSIONER OF EDUCATION
OF THE UNITED STATES



From a photograph of WJZ Station made for POPULAR RADIO by Westinghouse

The Advance Agent of the New Era

¶ *"We have as yet but caught a glance of the social destiny that radio will fulfil. . . . It will achieve the task of making us think together, feel together, act together, not merely as a nation but as a world!"*

—SEE PAGE 236

Popular Radio

VOLUME II DECEMBER, 1922 NUMBER 4

Is the "Heaviside Theory" Valid?

The Answer in the Negative, by DR. ELIHU THOMSON
The Answer in the Affirmative, by SIR OLIVER LODGE

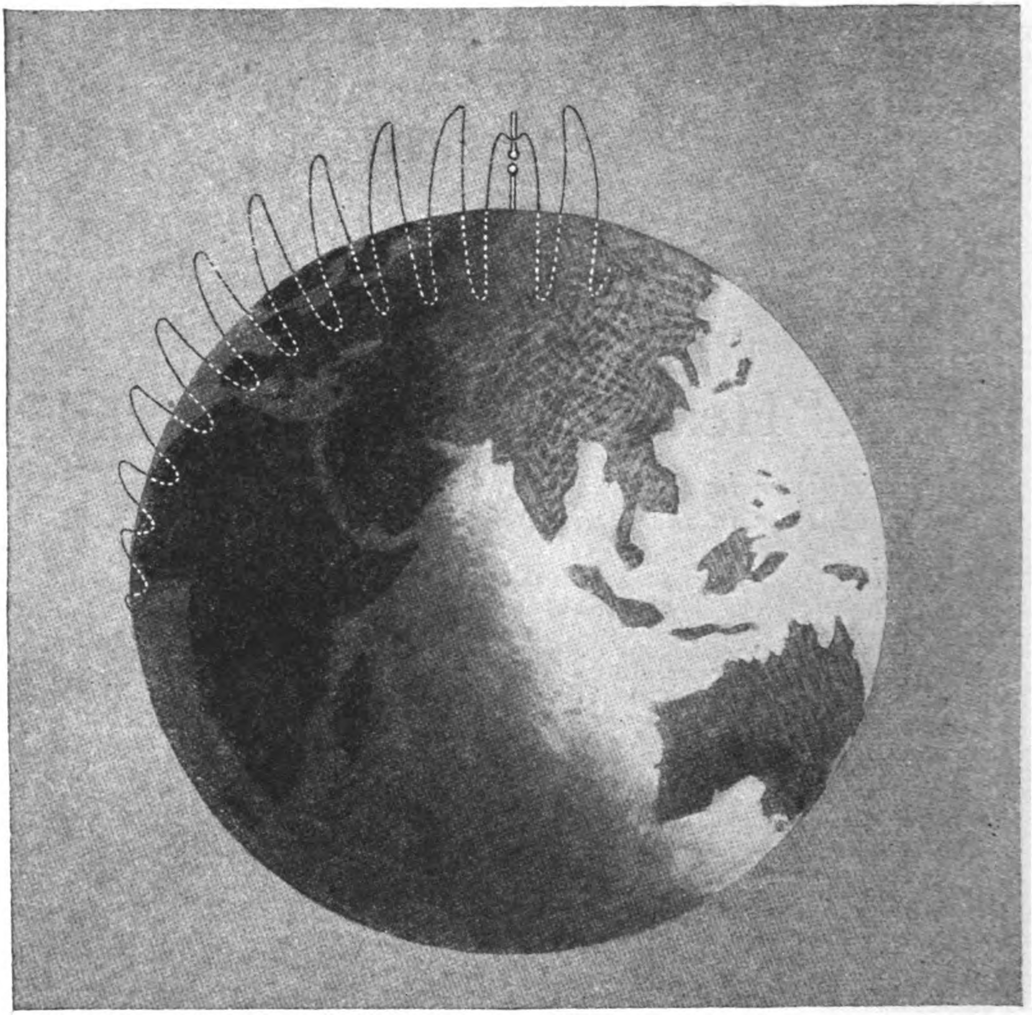
FOREWORD

WHEN Marconi's historic feat of transmitting signals across the Atlantic by means of "wireless" was established as a fact, a group of eminent scientists cast about for a theory that would explain how the radio waves were sent around the curvature of the earth. According to notions conceived up to that time, light waves and radio waves traveled only in straight lines. To explain this new phenomenon, therefore, a theory known as the "Heaviside layer theory" was evolved. This theory presupposes a spherical layer of ionized gas or minute conducting particles of matter, suspended about fifty miles above the surface of the earth; this layer is presumed to serve as a reflector and to bend or deflect the radio waves and thus send them around the earth in a circular path. Another group of no less famous scientists, however, emphatically deny the validity of this theory. They explain the phenomena by means of the "gliding wave theory," according to which the waves are led around the curvature of the earth by ground conduction. This latter theory is upheld by the distinguished American scientist, Dr. Elihu Thomson, who was one of the first great experimenters in this field. The other side of this discussion will appear in this magazine for January—written by the eminent English scientist, Sir Oliver Lodge.—EDITOR

BY ELIHU THOMSON, PH.D., SC.D.

WHEN Marconi brought out his system of wireless telegraphy about 1896, it was at first thought by most scientists or physicists of the time that it was a plain case of the sending out of waves of the Hertzian type, which Dr. Heinrich Hertz had so ably investigated ten years before. If such were the case, the transmission was necessarily in straight lines from the oscillator; necessarily, also, such waves could not follow the curvature of the earth's surface, but they must leave the earth as if they were light beams—another case of electromagnetic waves moving in a straight course.

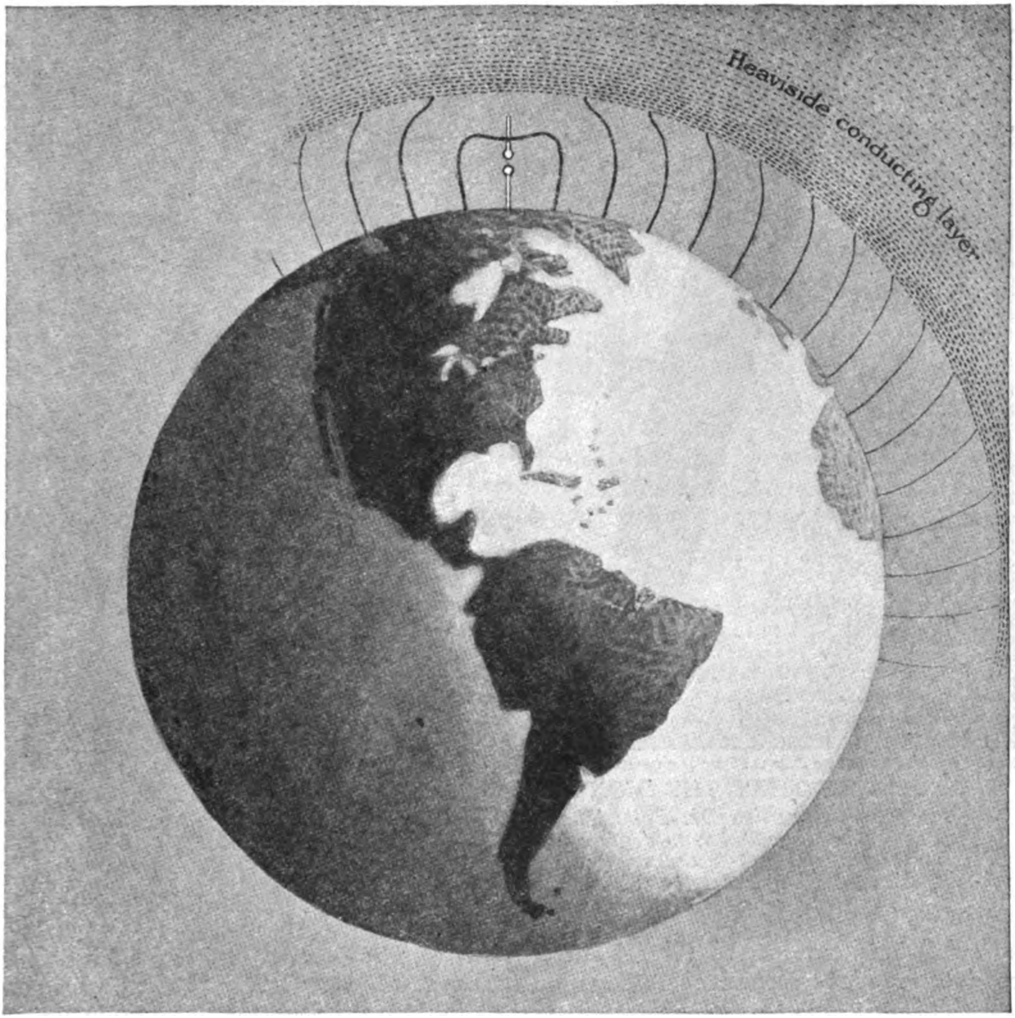
There were some of us, however, who, taking into account the grounding at the base of the antenna, recognized the fact that the Marconi transmission was not made by real Hertzian waves, but on account of the grounding, by half-Hertzian waves only, and that the Marconi oscillator or antenna system was a half-oscillator only. From this it followed that the waves were in reality attached to and guided by the earth's surface, and particularly by the sea surface, more conductive than the land.



THE "GLIDING WAVE" THEORY—WHICH DR. THOMSON ACCEPTS
"The radio waves are in reality attached to and guided by the earth's surface, and particularly by the sea surface which is more conductive than the land," states the American scientist. According to this theory, the half-Hertzian waves propagated from a grounded system would follow the curvature of the earth and would be accompanied by electric currents in the earth and sea surface, and by magnetic and electrostatic fields in the space above the earth's surface.

It followed that there would be electric currents in the sea and earth-surface accompanying these half-Hertzian waves, and magnetic fields overlying the currents in the space above the earth's surface.

When it was announced by Marconi a few years later that he had received signals across the Atlantic ocean by flying a kite, the cord of which constituted an antenna with the usual ground, many regarded him as something of a faker. At least, they believed that he was mistaken in his observations. Among these doubters were not a few of the leading scientific men and engineers of the day. It followed that if the waves were of true Hertzian type and were propagated in straight lines, they could not by any possibility curve around and over a mountain of water nearly two hundred miles high, as they would have had to do if they



THE "HEAVISIDE LAYER" THEORY—WHICH SIR OLIVER LODGE DEFENDS

The "conducting layer" theory, which is proving a bone of contention among scientists, assumes that this hypothetical Heaviside layer (which would have to present a smooth surface fairly impenetrable to the radio waves) bends these radio waves by successive reflections, without diffusing or mixing them up, around the surface of the earth. "This assumption," according to Dr. Elihu Thomson, "strains the imagination too far, and plainly will not work."

crossed the Atlantic close enough to the earth's surface to be detected.

As it was soon demonstrated that Marconi was right and that the signals *did* come around the curve of the earth's surface, those scientists who failed to recognize (and some of them even yet seem so to fail) that there was a fundamental difference between the waves in their propagation and in their generation as regards true Hertzian waves, had been mistaken—and not Marconi.

Then a singular thing happened.

When confronted with the facts, this assumption pure and simple was made, which unfortunately lives and has character even today: that there was an electric mirror of ionized gas, or conducting gas, say fifty or sixty miles up in our atmosphere, the under surface of which was so definite as to reflect the waves without diffusing or mixing them up, and

From a photograph made for POPULAR RADIO by General Electric

HE BELIEVES THAT THE "CONDUCTING LAYER" THEORY IS A FALLACY

No one can question Dr. Elihu Thomson's standing as an authority on electrical phenomena. In addition to degrees from several universities, membership in many learned societies and decorations from foreign governments, he holds the Rumford, Fritz and Edison medals in science. He is the head of the Thomson Laboratories of the General Electric Company.

so send them around the earth by successive reflections from above.

I think that anyone who reflects for a moment on the requirements in such a case must predict that such an assumption is not only unnecessary, but that it strains the imagination too far, and plainly will not work. In order to work, it would have to be something like a metal surface, confined to a certain smooth regularity and of such a nature that the wave fronts could not penetrate it to any considerable depth without being turned back. It must be without swellings or wavy contour, and it must reflect the waves in such a way as not to interfere with those that are more directly transmitted, and so keep the waves in phase. It would have to be, as it were, Nature's gigantic whispering gallery for electric waves. The assumption itself (if it could be shown to be probably true, with the required limitations) might have justified the extended and complicated mathematical treatment it has received at the hands of some able men. But an assumption, if not needed or not true, is not helped by such treatment. The mathematics may be valid enough, but they do not make the assumption itself valid. Reasoning on false premises, whether mathematically or otherwise, does not make the conclusions valid.

According to what has for many years been known as the "gliding wave" theory, there never was and never could have been any doubt of the waves used by Marconi (the half-Hertzian) following the rotundity of the earth's surface.

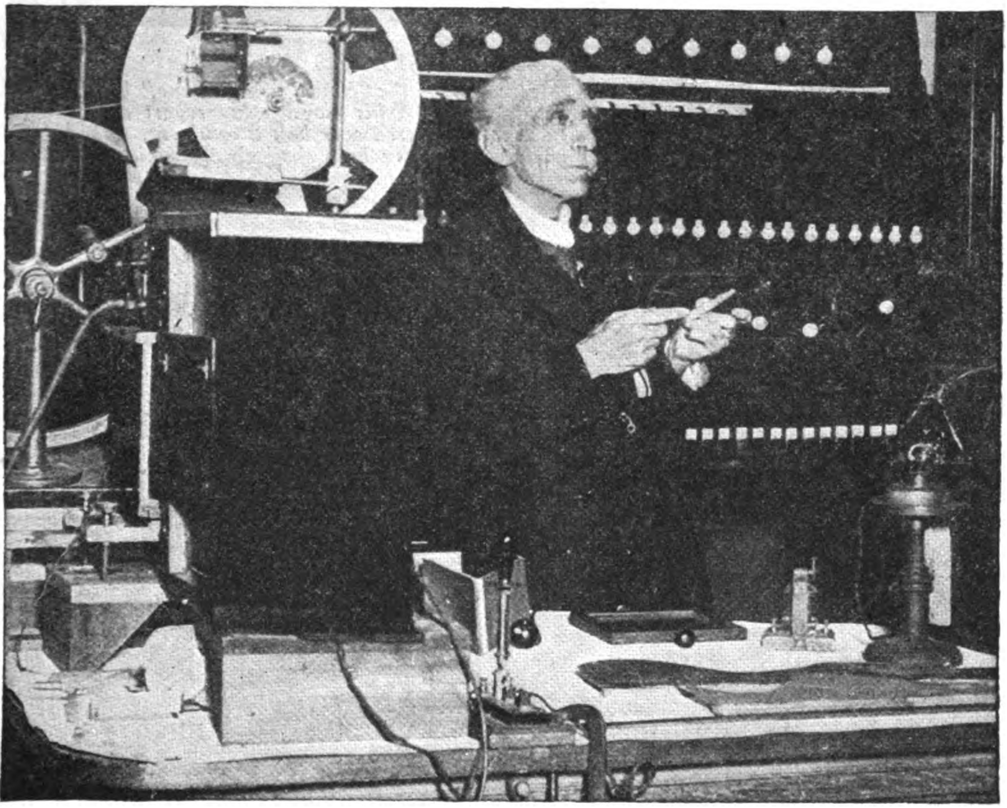
Experience shows that transmission over the sea is far better than over the land. Direction finding discloses that the direction of transmission favors the sea.

Experience shows that when the land surface between two stations has been wetted by rains, great improvement in the transmission follows, to be again lost when the land surface is once more dried by evaporation. A good ground for the transmitting system or an ample condenser counterpoise is shown to favor greatly the launching of the waves. That the waves above the earth's surface tend to follow closely that surface, or may even be said to cling thereto, accords with the results obtained from ærial antennæ, ground antennæ and loops or coils used as antennæ.

There never has been any occasion for the existence of the assumption of an upper conducting layer of such a nature as to reflect the waves without confusing them or diffusing them, and it is regrettable that such an assumption, having once received the sanction of great names, thereby continues to have a support and recognition which should never have been given and was never needed.

The views presented by me in 1913* have been more and more confirmed by practice in the years since elapsed. They represented the views of the group, by whom the assumption of an upper reflecting layer was recognized from the start as a fallacy.

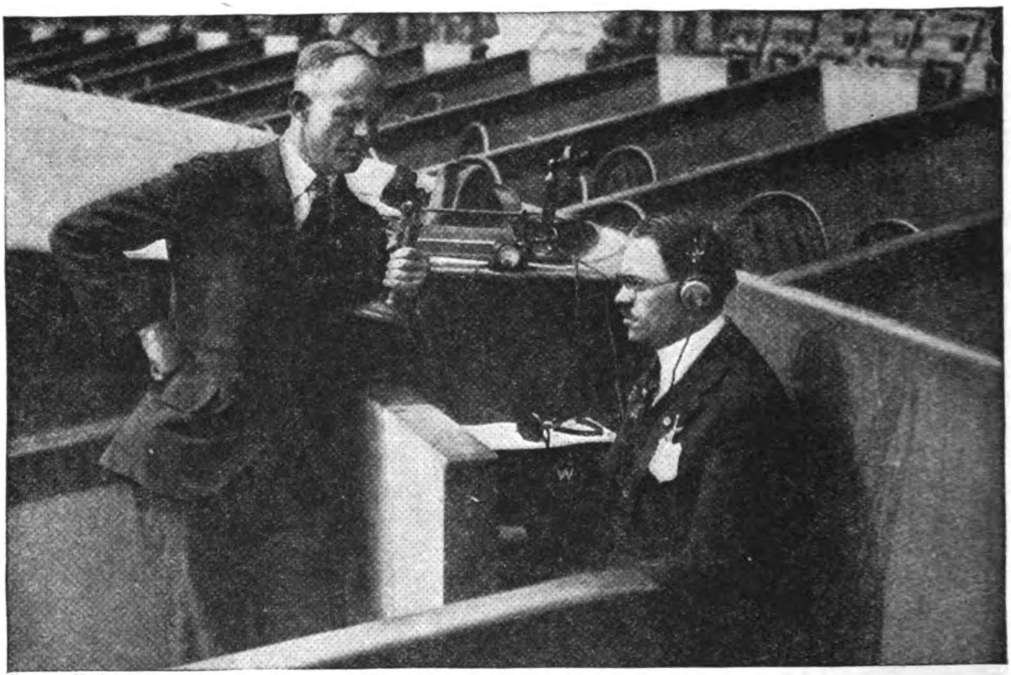
**See "Wireless Transmission of Energy," published in the Report of the Smithsonian Institution for the year 1913, pages 243 to 260, inclusive.*



Kadel & Herbert

ONE OF THE EARLIEST BELIEVERS IN THE HEAVISIDE THEORY

An apostle of the Heaviside theory, Dr. J. A. Fleming, F.R.S., a scientist and physicist of the highest type who has contributed many valuable books on scientific subjects and has made exhaustive researches in radio and the characteristics of dielectrics. He is the inventor of the Fleming valve, the first vacuum tube used in radio.



Kadel & Herbert

4,000,000 BASEBALL FANS HEARD HIS VOICE

When Grantland Rice, the popular sport editor of the "New York Tribune," broadcast from the New York Polo Grounds via WJZ his play-by-play report of the world-series baseball games, his audience was scattered over half a continent. Grand opera, symphony concerts, lectures and speeches have been similarly transmitted by wire to broadcast stations. The immediate problem before the broadcasting stations today is to obtain the wire service.

WHO WILL PAY FOR

BROADCASTING?

A Frank and Searching Outline of Radio's Most Pressing Problem and the Possible Ways of Solving It

By WALDEMAR KAEMPFFERT

The Broadcasting Crisis in a Nutshell:

UPON the nature of the broadcast programs the public interest in radio—and consequently the immediate future of the radio industry—is hanging.

When radio first seized upon the public fancy, interest was centered on the radio apparatus itself—the mechanical medium by which the broadcast programs were received. The novelty of the instrument must inevitably pass. The public's interest is properly becoming centered on the programs themselves.

Radio is unquestionably destined to play a vital part in the affairs of men, perhaps a more vital part than has ever been played by a single invention or discovery. It is vastly more than a mere instrument for receiving jazz, bed-time stories and similar light entertainment. It has already demonstrated its significance as a great educational and cultural force. The foremost educators and publicists of the country are beginning to realize its possibilities. Radio is beginning to take its place as an instrument for rendering a world-wide public service of inestimable value.

The day when eminent musicians, lecturers and others can be induced to visit remote broadcasting stations and entertain free of charge is passing.

To meet this situation POPULAR RADIO has proposed a nation-wide broadcasting project that offers a practical solution that *can be put* *into immediate effect.* It aims to raise the broadcast programs to the highest possible level, to the end that they may be coordinated and made to serve a great public service.

Briefly, the plan provides:

1. For the installation of permanent wiring to the more important auditoriums where musical programs, lectures by eminent scientists and publicists, and other important features are given.
2. For the transmission by wire, to a small but highly select group of powerful and adequately equipped radio stations, such programs as may be selected for broadcasting.
3. For the coordination of these important features as elements of an organized program, developed on a nation-wide scale, under the direction of properly constituted authorities that may include the country's foremost educators, scientists and patrons of the fine arts.

In other words, the plan provides for reaching out and tapping those auditoriums, lecture-rooms, opera houses, concert halls, athletic fields—possibly even the halls of Congress—to the end that the world's greatest music and the world's greatest scientists and publicists may be figuratively brought into the home of every radio fan—and eventually into every school and college.

That the project is eminently practical from a technical standpoint has been repeatedly demonstrated, notably by the broadcasting of the Philharmonic Orchestra concerts from the City College Stadium in New York last summer—an enterprise initiated by this magazine.

The project has been outlined to some of the leading educators, scientists and patrons of the fine arts in the country, who are not merely giving it their endorsement but in many cases are giving it their active cooperation.

To carry this project (or any similar project) into effect requires wires. Without wires the programs cannot be conveyed to the broadcasting stations.

The immediate problem is: How may the necessary wires be obtained?—EDITOR

DR. FOSTER of Newark felt constrained to open a broadcast sermon with the words: "I cannot address you as citizens of Newark because my voice is being heard beyond the limits of the city. I cannot address you as fellow Americans because my voice is being heard perhaps in Cuba, in Canada, and in Central America. I cannot address you as brethren of my faith, because only a very insignificant part of the great number who are listening to me are of my own faith. And, therefore, I must address you as fellow human beings."

Here we catch a glimpse of the social destiny that radio will fulfil. The United States shrinks into a pocket handkerchief, the world into a little ball that can be held in the hand. We boast of the magnificent distances that make these United States what they are; yet, because they are magnificent, these distances estrange us. To most of us Oakland, Seattle, St. Louis are mere places on the map. An idea holds us together—the idea that we of St. Louis, Chicago, and New York are all citizens of the same commonwealth. Radio will achieve the task of giving a reality to this idea.

Henceforth the actual voices of Presi-

Brown Bros.

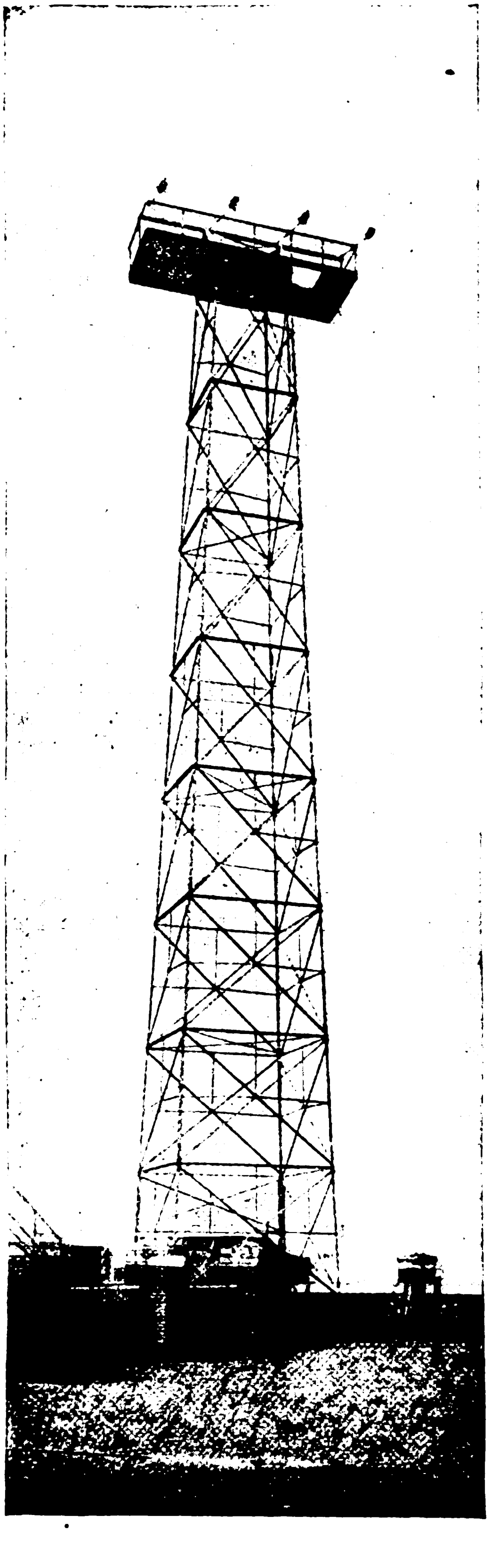
Broadcasting as an Educational Force

TO THE EDITOR OF POPULAR RADIO:

"I fully appreciate the very great educational possibilities of broadcasting, and let me also say that I am in every way sympathetic with the movement which will bring to the great masses of the people the opportunity to hear by broadcasting the exceptional concerts which are given by such organizations as the Philharmonic, as well as to hear our great singers and lecturers."

Clarence H Mackay.

President, the New York Philharmonic Society



dents and Governors will be heard by the people. No longer will we be content with the cold, impersonal type by which official proclamations and messages now reach us. The President of the United States will be a real personality—something more than an abstraction. He will literally enter every home when the occasion justifies his addressing the people of the United States in person. Solemn as was Woodrow Wilson's declaration of war on the memorable day when he called upon Congress to break with Germany, a thousand times more solemn would have been the accents of his living voice than were the scareheads by which his declaration was announced by the newspapers.

The phonograph has brought the interpretations of great musicians into the homes of lonely farmers and ranchmen. But radio will carry to the great open spaces the plays, the lectures, the operas that make city life what it is. It will link Fifth Avenue millionaires with Wyoming cow-punchers, sailors on lonely seas with Massachusetts mechanics. The lumberman of the north woods, the sugar-planter of the south, the California fruit grower and the Virginia tobacco planter will become next door neighbors of the ether. Radio is destined to transform the United States, the whole continent, into a huge auditorium.

¶*But before anything remotely resembling this radio millennium can come to pass, broadcasting must be organized as a business.*

Present-day broadcasting is an astounding anomaly. Probably the manufacturers of radio sets who first timidly began to entertain the multitude and who were amazed at the overwhelming, enthusiastic response of that same multitude never realized that, like nobility, broadcasting imposes obligations.

THE MOST SIGNIFICANT STATION IN AMERICA?

Despite the fact that WBAY has met with unexpected technical difficulties and is still inoperative pending "experimental work," it may yet prove to be the storm center—or the solution—of the whole broadcasting problem.

Like the lawyers when they cross-examine an expert, let us ask a hypothetical question or two.

Assuming that within the range of WPQ, the manufacturer who pays the expense of maintaining the station has sold all the sets that the territory will absorb, will he continue to pay from $2,000 to $10,000 a month to instruct and amuse his one-time customers, as well as the customers of his competitors?

Or, will he pocket his profits and stop broadcasting then and there?

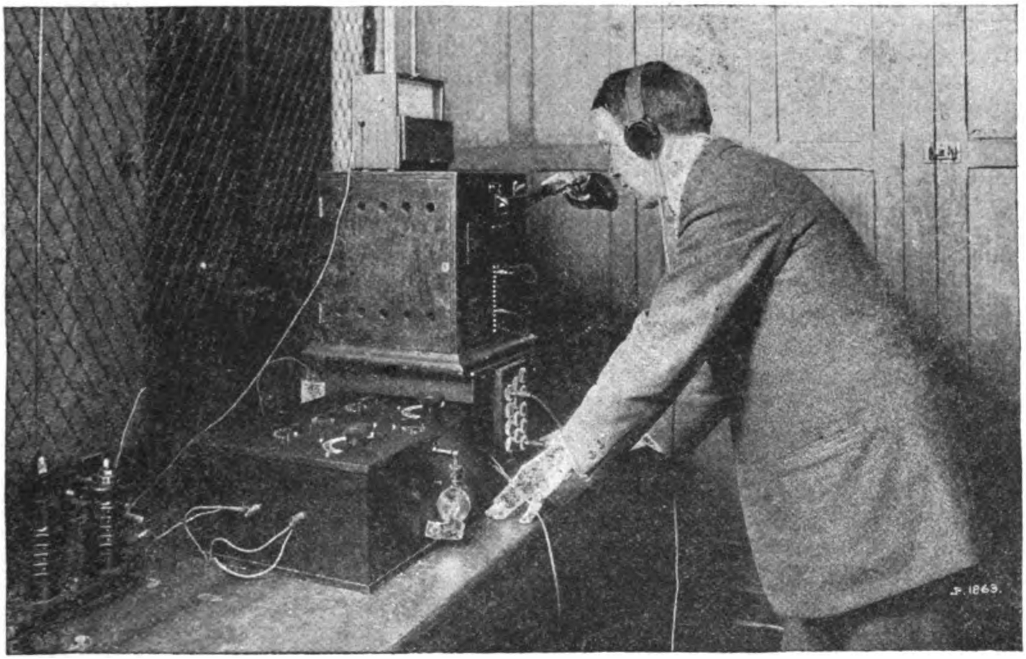
We have but to ask these questions to expose the inmost nature of the broadcasting station's true function. *Broadcasting is essentially a public utility.*

The department stores and newspapers may have the right to close their stations, but the manufacturer of radio sets who has taken it upon himself to radiate music and lectures into space, primarily in the interest of those who have purchased his apparatus—dare he stop? Will he be permitted to stop? Is not his reputation for honest dealing at stake?

Clearly, there is a radio burden as well as a White Man's burden.

The time is rapidly approaching when the novelty of singing for nothing into a transmitter will wear off, when artists, actors, and professional lecturers will ask: "What is there in it for me?"

Professional entertainers do not live by publicity alone. Broadcasting is bound to become more and more expensive as the public demand for better and better programs becomes more and more insistent. The electric light company that supplies current, the city street railway system that provides cheap transportation, the water company upon which thousands are dependent, the public utility company that renders any service whatever cannot afford to ignore the rights of those that it undertakes to serve. And broadcasting is already a public utility. Some way must be found of making it profitable.



RADIO SERVICE TO MOVING TRAINS

As long ago as 1915 the Lackawanna Railroad experimented successfully with radio communication between its headquarters and its trains en route. Last August the concerts of the New York Philharmonic Orchestra were heard on Lackawanna trains in Pennsylvania.

Someone has cried: "Let the Government levy a tax on radio receivers and contribute the proceeds to the support of broadcasting stations."

In Europe, familiar as it is with operas and theaters supported by the state and the city, it is conceivable that money might thus be raised. But a radio subsidy in America—never. We haven't even a national theater or a national opera.

Radio blazed into being, so far as the general public is concerned, simply because the broadcasting station flashed song and speech into space. Broadcasting stations must be maintained, and expensively maintained, if this marvelous interest is not to languish and die overnight. And that it will be maintained there can be no doubt. To keep the public interest alive some means must be devised of collecting revenue from the public. But how?

The Radio Apparatus Section of the Associated Manufacturers of Electrical Supplies, comprising at present about twenty of the more enlightened and progressive makers of radio apparatus, has expressed its willingness to share the financial burden imposed by broadcasting. The business of broadcasting is to become co-operative, and the self-imposed taxes will, of course, be passed on to the public after the manner of all taxes. Upon the apparatus of the contributing manufacturers the insignia of the Association is to be placed—a symbol signifying that they have recognized their obligation and have met it by the payment of a fair levy. No doubt a few "get-rich-quick" manufacturers will refuse to pay the slight, just tribute demanded, but the conspicuous absence of the Association's insignia from their sets will proclaim these Wallingfords of the industry for what they are. Whether or not the public will be moved by its sense of fair play to refrain from buying instruments that are not thus identified by the Association's seal, remains to be seen.

If co-operative broadcasting is thus undertaken by most of the manufacturers, one station will take the place of many stations. The interference that now marks attempts to receive on wavelengths that differ from one another by only a few meters will disappear. Moreover, not one company but many companies will dictate the character of programs, and broadcasting will more accurately reflect the public taste.

One unique plan is that devised by the American Telegraph and Telephone Company as the result of an "insistent demand" for broadcasting facilities. The company's manufacturing subsidiary received numerous orders for private broadcasting instruments, which, had they been made and sold, would have increased the difficulty now experienced in avoiding interference. Moreover, there were many small firms that could not afford to install their own transmitting stations and that wanted to make the most of radio's possibilities. *Broadcast for hire* was the solution. So, the American Telegraph and Telephone Company has built an experimental station (WBAY, located in New York City), which may be rented for a definite time at a fixed price by anyone who has a message to convey or a song to sing.

Assume that you are a manufacturer of pianos. You wish to impress a vast radio audience with the tone quality of your instrument. You hire the station for an hour a day, three days in the week, for two months. The announcer introduces himself and his subject, "Signor Pablo Portadino, the well-known baritone of the Metropolitan Opera House, will sing the Prologue from *I Pagliacci*, accompanied by Giuseppe Martucci on the Benson concert-grand piano." Giuseppe strikes the opening chords and Portadino proceeds to explain in rich Italian tones that the players on the stage are only human. The tone quality of the piano must make some impression.

Or, you are a manufacturer of vacuum cleaners and you wish to instill in your

Photo by Post-Dispatch, St. Louis

A PILLAR ON WHICH THE RADIO INDUSTRY RESTS

Such broadcasting stations as this one (KSD in St. Louis) keep alive the public's interest in radio. It may soon become part of a great radio net for relaying the world's best music and the voices of the world's foremost scientists, educators and publicists into every home and school, as part of a nation-wide educational program.

unnumbered audience a holy fear of dust. You describe alarmingly what work a broom does in casting up disease germs. Then you contrast these unhygienic, preposterous proceedings with the modern sanitary method of vacuum-cleaning. "To anyone who brings us orders for five Supreme vacuum cleaners," your hired tempter concludes, 'the Supreme Vacuum Cleaner Company will give a crystal-detector radio set."

Or, you are running for Mayor of New York and you are opposed by too many influential newspapers. To reach the voters you plead with them for half an hour each night over a period of two weeks preceding election.

The plan has possibilities. To be sure, the advertiser, the political candidate, the social reformer, the religious fanatic will be the first to avail himself of the golden radio opportunity presented. How will the public respond? It is impossible to foretell. If the lecture is dull, if the musical bait offered by the piano manufacturer is not appetizing enough to be swallowed, it is assumed that the radio audience will voice its disapproval by letter to the firm or orator responsible for a dull radio time.

In the evening, the station will broadcast sheer entertainment—music, talks on interesting subjects, stories. The morning and other hours of the day will be reserved for the advertiser and the propagandist. No matter what price he may be willing to pay he must not trespass on the evening, unless he is ingenious enough to devise a feature that will harmonize with a concert program. When the government finally allocates wavelengths the station will modify this policy. Instead of limiting the advertiser and the man with an axe to grind to a specific time of day, the station will assign him to a wavelength on which he may expound to his heart's content at any hour that happens to be available.

The government has already indicated that it will not permit a wholesale abuse of radio by the advertiser.

On the other hand, advertising on some wavelengths will be permitted. If advertising proves to be the American Telegraph and Telephone Company's chief source of revenue, it will have to be of a new, almost hypnotic variety. It must hold the interest as if it were a play or a comic opera. Lecturers must be found as winning and convincing as the serpent in the garden of Eden. If the hired stentor contents himself with: "Ladies and Gentlemen, the Morpheus mattress, which is made by the well-known Rosenberg Company of Kalamazoo, has the softness of a downy cloud and the durability of battleship armor," his audience will yawn and glide to a wavelength on which Al Jolson is singing "April Showers," or a popular jazz orchestra is playing the latest fox trot.

But the American Telegraph and Telephone Company is not concerned with these aspects of radio propaganda. Its sole business is to operate a station for hire; it leaves possible patrons to their own devices. It will certainly be cheaper for newspapers and department stores to hire such a public service station by the hour than to conduct stations of their own. From these sources alone revenue enough may be earned to pay all broadcasting costs.

But what of opera, what of artistic song recitals, what of lectures by distinguished university professors—lectures purely educational in character?

The company will do much to use radio for this purpose at first during the evening hours and later on special wavelengths. Perhaps a Carnegie, ashamed to die rich, will hire the WBAY station and pay theatrical managers for the privilege of brightening thousands of homes. It is music and lectures, sent through space, without thought of any direct personal advantage to the broadcaster, that have made radio what it has become. If the American Telegraph and Telephone Company has actually conceived the most practical plan of placing radio broadcasting on a sound business footing, possibly municipalities may pay the royalty that will unquestionably be demanded by the producers of operas and plays. And why not? Every self-respecting community now taxes itself for parks and the bands that play in them.

If the American Telegraph and Telephone Company's experiment proves successful we shall undoubtedly witness the establishment of broadcasting stations that can be hired by the hour, day or week, all over the country—stations interconnected by special wires so that the radio address delivered in New York may be simultaneously broadcasted from Maine to California. Other engaging possibilities suggest themselves. A public utility broadcasting service, such as this, nation-wide in its scope, may well claim from the Government the right to radiate on a dozen different wavelengths, so that concerts may reach us on one, the news of the day on another, educational discourses on a third, artful propaganda on a fourth.

Certainly one broadcasting station, subject only to such control as the Government may impose, is more likely to serve the public better than a number of stations in the same community. Indeed, as time passes and radio develops, a few broadcasting stations, erected at strategic points, will probably take the place of hundreds that are bound to be established within the next year or two. There will be less interference, and the tuning will be sharper and more selective.

Broadcasting stations are now far too eclectic. They give us weather reports, stock market quotations, orchestral music, bedtime stories for children, lectures, and Arlington time. The Government regulations, being what they are, we must accept what reaches us on the prescribed wavelength whether we like it or not. There is little opportunity of "tuning in" to receive what another station has to offer, if the closing prices on the stock exchange do not interest us, simply because near-by stations all transmit on the same wavelength and must so time their programs that there will be no interference. Mr. Hoover's commission has allocated wavelengths, and if its

WHO PAYS FOR SUCH STATIONS, AND WHY?

Properly enough, Boston's foremost broadcasting station, WGI, is located within the grounds of Tufts College. Who will eventually pay for maintaining broadcast programs?

Westinghouse

WILL RADIO PUT THE SMALL CHURCH INTO THE DISCARD?

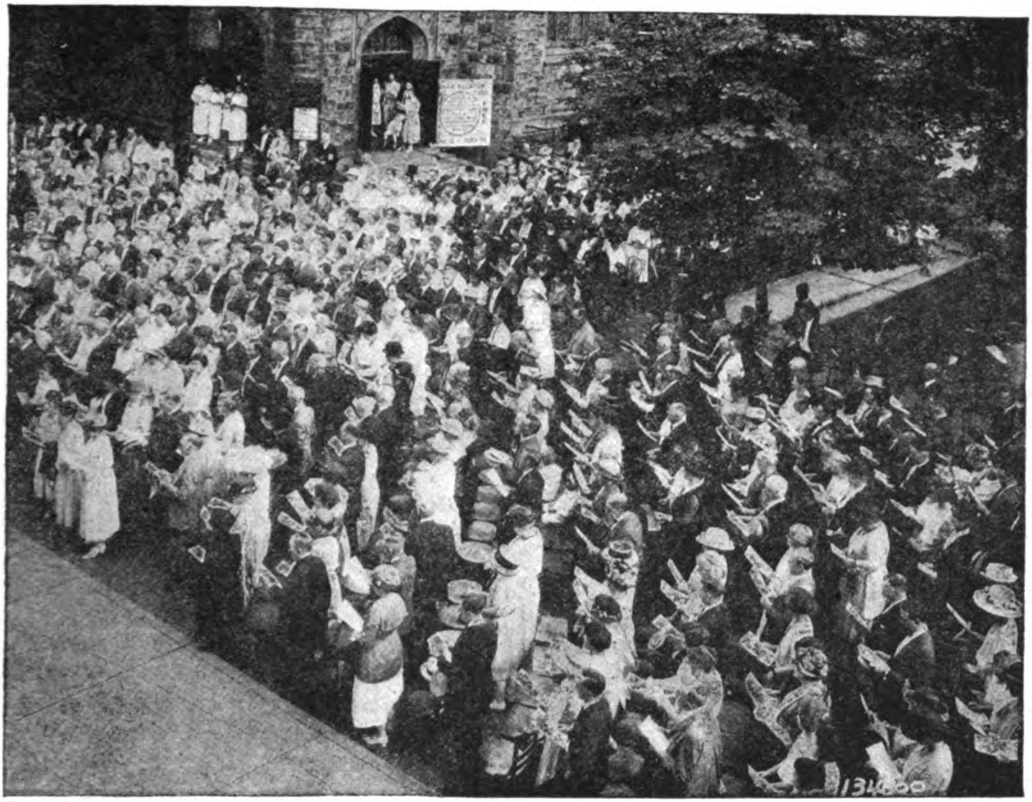
This particular community service in Pennsylvania was broadcast from KDKA. Services in the country's foremost churches may be similarly broadcast—with the aid of wires to the radio stations.

recommendations become Governmental regulations, radio entertainment and instruction will reduce itself to a matter of wavelengths rather than of stations. In other words, sporting news, symphonic music, song and instrumental recitals, dance music, stories, and lectures will each be radiated on its own wavelength.

Hence, the receiving set of the future may possibly be provided with tuning dials bearing such legends as "Jazz," "Opera," "News," "Market Reports," "Musical Comedy," and "Symphony Orchestra." We shall turn the dials of our sets to the proper legend and listen to that which happens to interest us most at the moment.

Whatever may be thought of the practicability of the significant experiment of the American Telegraph and Telephone Company, the ultimate possible linking of our wire-telephone system with a score of broadcasting stations that can be hired, as one hires a taxicab, reveals the true relation of radio to the wire system of communication, although the company intends to connect stations by special wires. Only a fantastically optimistic radio enthusiast cherishes the illusion that radio will completely supplant wires—that all the miles of wire, all the complex, ingenious switchboards in central stations, all the expensive conduits that encase cables will be scrapped. The truth is that radio will prove to be a valuable extension of the network of wires that enmeshes the country and the continent. In the future drama, music, entertainment will be picked up wherever it is available at its best and carried by wire directly to the broadcasting station.

"We shall have the pleasure of listening to Madame Rubin, late of the Warsaw Opera, in a rendition of the Mad Scene from *La Gioconda,*" announces the voice at the broadcasting station. In these paleozoic days of radio, Madame has obligingly motored, trolleyed, or otherwise transported herself to the broadcasting station, there to plant herself in front of the transmitter and give her full-throated best. In the near future, Madame will exercise her prima donna's right of displaying her temperament and of singing, when, where and how she pleases. Instead of transporting her heaving bosom to the broadcasting station, she will sit at home, sing into a transmitter, and her voice will be carried by wire to the broadcasting transmitter by which it will be prodigally radiated into space. At present, the sheer novelty of singing from a broadcasting station, of momentarily converting herself into a vocal sun that shines into thousands of homes is enough to induce her to present herself in person at the station. If



Westinghouse

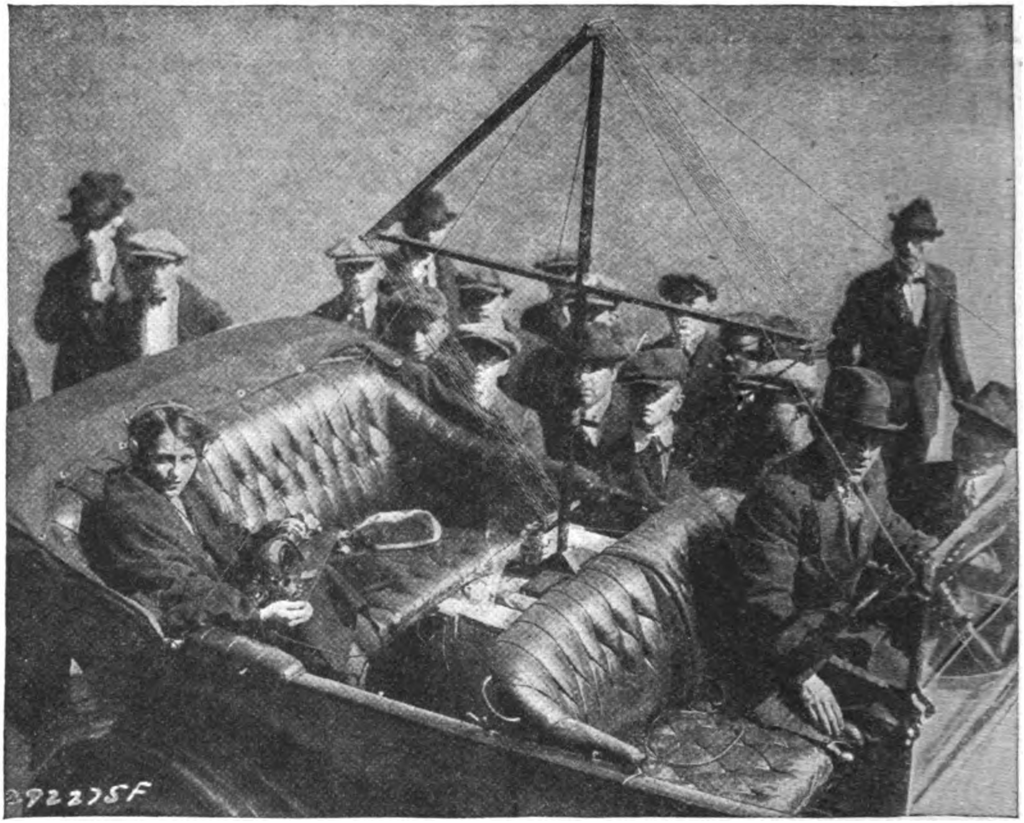
Madame only knew that even now she might sing to millions in her boudoir, clad in a comfortable kimono!

"Listeners-in" there will always be in the great cities, but it is in enlivening the dull small town and the lonely farmhouse, in robbing the great open spaces of their loneliness and monotony, that radio will probably play its most important part. Hence, we may find broadcasting stations serving both the country and the city by radio and telephone.

The use of city telephone wires to bring to apartment-house dwellers the strains sung into the transmitter of a distant broad-casting station suggests an extension by the carrier-wave system of what may be called "narrow-casting." The system has been so frequently discussed, particularly in the pages of this magazine, that the principle upon which its operation is based need not be elaborated here. It is enough to recall that high-frequency currents can be transmitted over telephone or power line without interfering with one another or with the currents for conducting which the lines are built. There would be no difficulty about collecting revenue. The telephone company would rent an extra telephone receiver, even a loud-speaker, to each subscriber. "Plug in" and you hear the music transmitted from the central station.

Similarly, the electric light companies could narrowcast over their own lines. They have but to install the necessary high-frequency transmitting apparatus and to supply proper receiving instruments.

When telephone or power lines are thus used for wire narrowcasting there will be none of the interference that now marks radio broadcasting. Gone will be the dots and dashes of the telegraphic spark-set, and gone the grinding of static. Gone, too, will be the possibility of getting something for nothing by "listening in" with a home-made receiver.



© Underwood & Underwood

PRACTICAL—BUT INCONVENIENT

If this motorist really wants to receive broadcast programs, this installation may be commended on grounds of efficiency. But it is a bit spectacular for the average fan.

Radio on Your Motor Car

Eight Ideas for Installing a Receiving Set That Will Really Work

By FREDERICK SIEMENS

TO install a radio receiving set on your automobile is a thoroughly practical undertaking—provided, of course, that you observe the approved scientific methods of installation and disregard the fantastic conceptions of inexperienced novices or publicity seekers, who rig up "stunt" sets that are designed rather to attract attention than to receive radio signals. There are few outdoor uses of radio that have excited more popular interest than its application to the pleasure car; yet the number of fake installations that do not work has tended to discredit such attempts on the part of the amateur.

There is no reason, however, why such installations should not be widely popular; indeed, the rapidly growing number of them would indicate that they are opening up new possibilities for enjoyment, particularly during the fall and spring months when the weather conditions are propitious for outdoor sports and when the static is not a serious factor In some cases the success of such radio-equipped motor cars has been so marked that sets supplemented by loudspeakers have blocked the traffic and called for police interference.

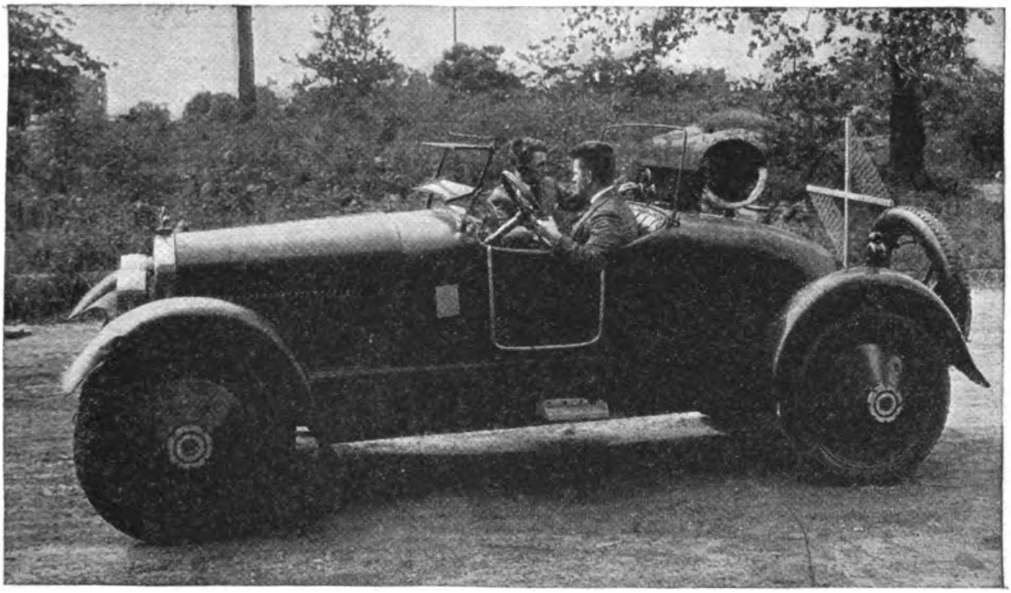
The most important point to be considered in such an installation is the type of energy collector or antenna which is to be used.

First of all there is the vertical loop antenna. This type of antenna gives good results; but to attain the maximum efficiency it must be pointed directly at the transmitting station, and this is not always possible on account of the ungainliness of the apparatus. Who, for example, would care to have a loop such as is shown at the head of this article, permanently installed on his car?

Of course, a miniature vertical loop can be installed somewhere out of the way on the car, as is shown in one of the other pictures, but even in such a case the whole car must be pointed at the transmitting station in order to get loudest results.

One interesting application of the loop type of antenna to automobile uses is that used by E. B. Myers in the set he designed for Miss Corinne Griffith, the film actress. This apparatus is in effect a portable radio set with radio frequency amplifiers and a vertical loop antenna fashioned into the cover of the valise-like carrier. When the set is in use the lid is opened and the whole set is turned until the received signals are heard most clearly. This set can be placed on the seat of any motor car, as it takes up scarcely any more room than a person, even with its equipment of batteries. With such an outfit it is reported that broadcasting programs can be heard a distance of fifty miles or more. Six tubes are used for this purpose, including three stages of radio and two stages of audio frequency amplification, and a detector.

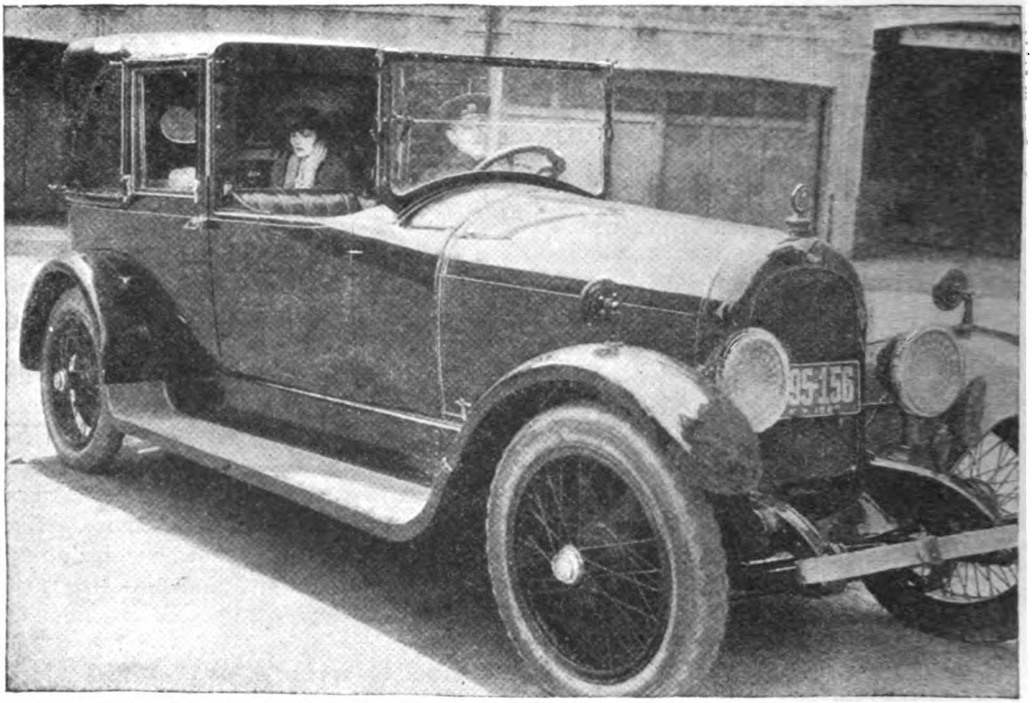
Another form of loop antenna which can be used successfully is known as the "horizontal loop." This type of antenna is particularly adaptable to installation



From a photograph made for POPULAR RADIO

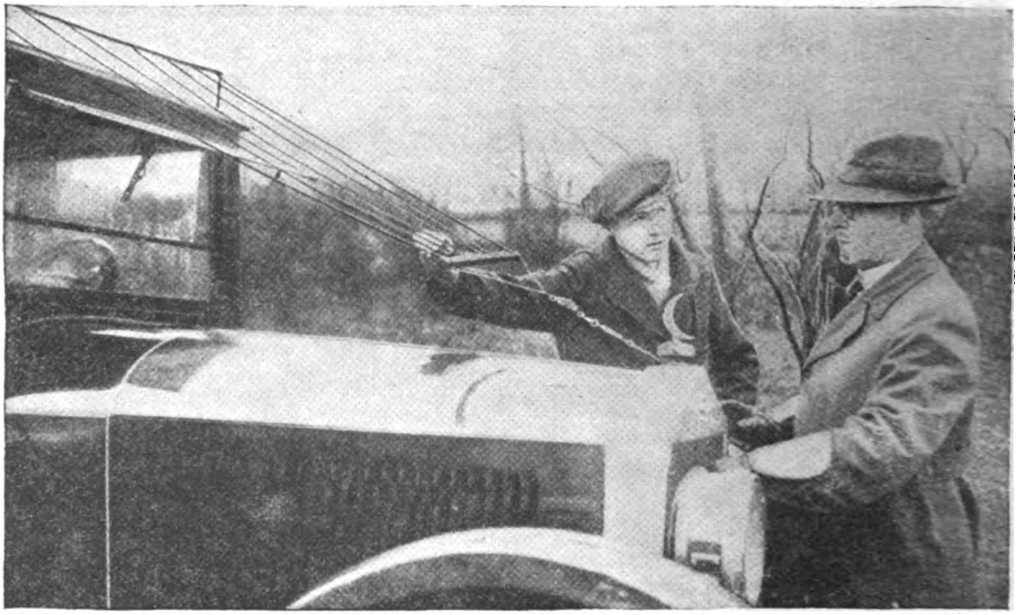
THE ARMSTRONG SUPER-REGENERATIVE SET ON AN AUTOMOBILE

The vertical loop, located at the rear of the car, in combination with a loudspeaker, creates such a volume of sound that the owner was warned by a traffic policeman in New York against collecting a crowd that obstructed traffic.



A PORTABLE SET DE LUXE

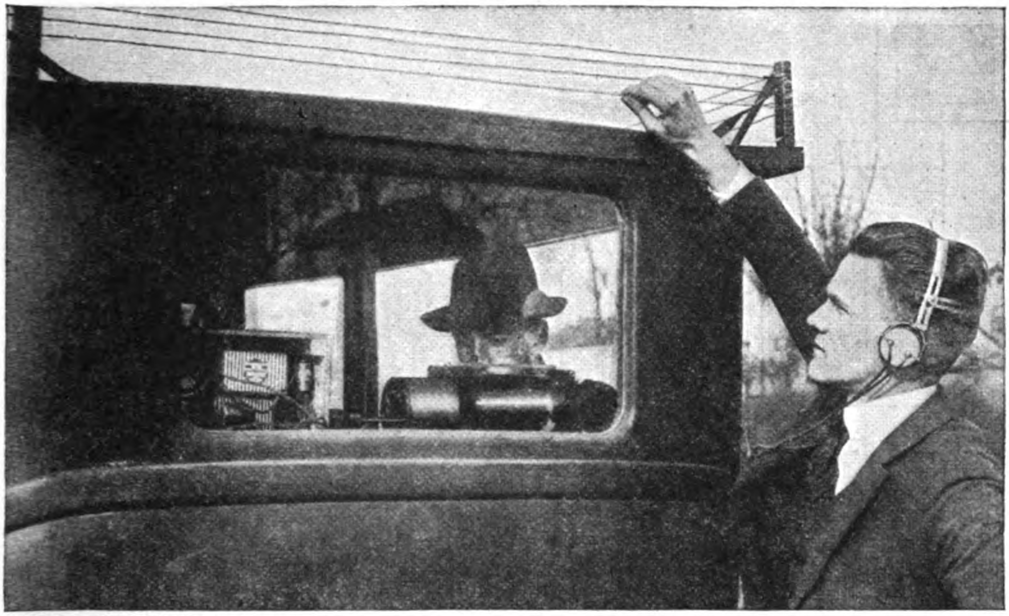
The loop antenna, the property of Miss Corinne Griffith, the film star, is coiled in the leather case of the portable receiving set, which may be carried about and used with no more inconvenience than a traveling bag.



International

THIS ANTENNA IS DRAPED OVER THE TOP OF THE CAR

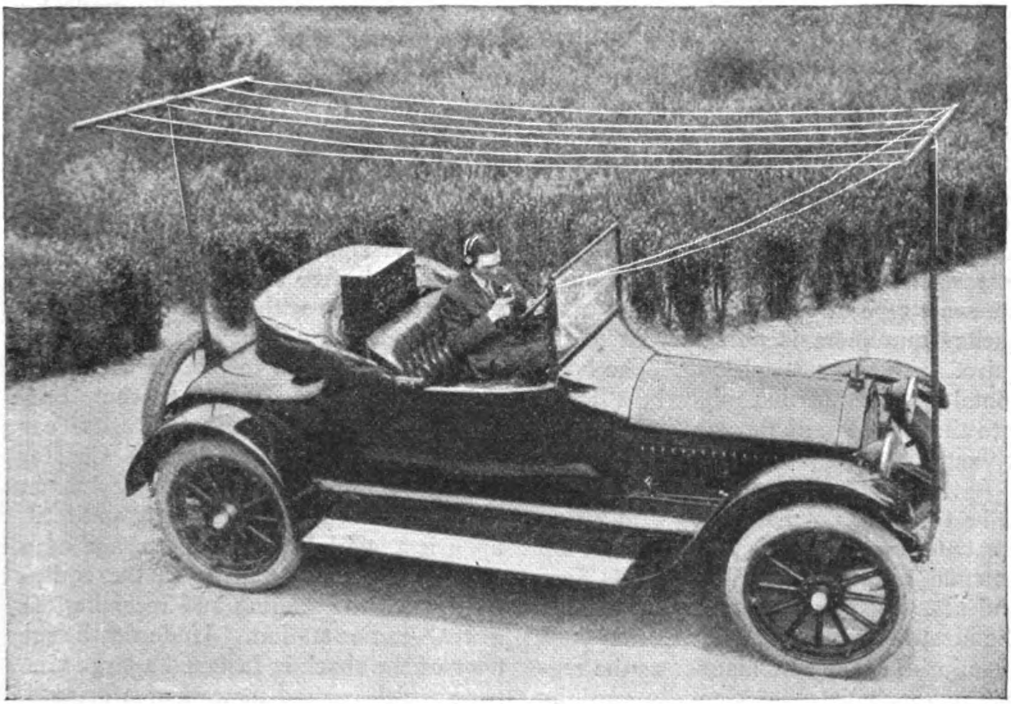
A Chicago physician, Dr. David Cottrell, uses the radiator cap as one support of his antenna and the rear tire rack for the other.



© Underwood & Underwood

A HORIZONTAL LOOP ANTENNA ON THE ROOF OF A LIMOUSINE

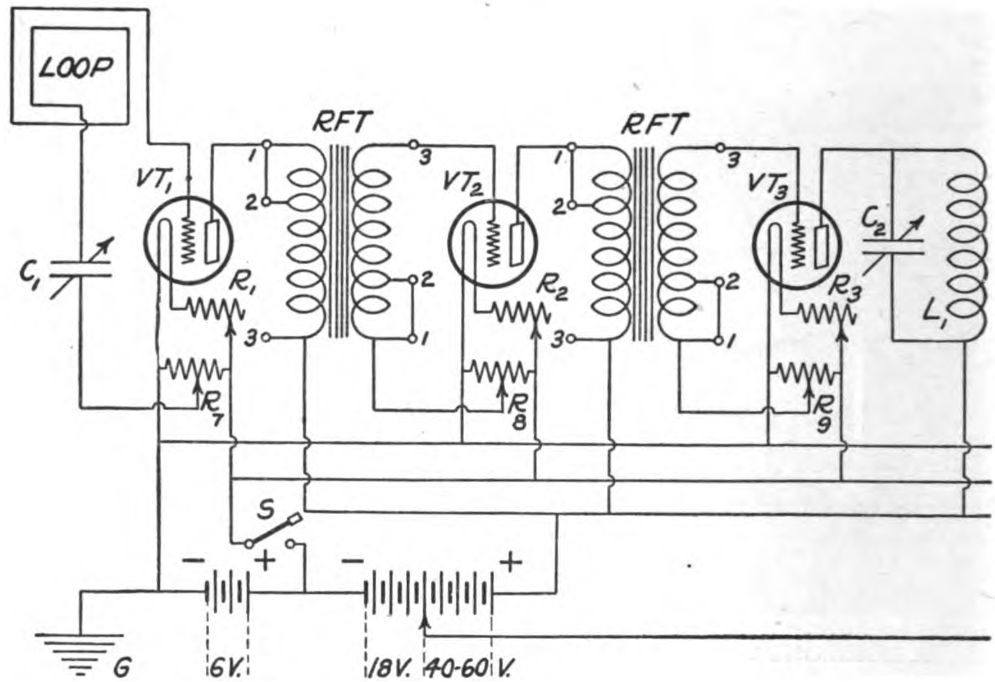
This installation may be made a permanent fixture on the car, and has the advantage of being out of the way. This set, owned by a Cincinnati fan, cost $50.



Pacific and Atlantic

CUMBERSOME—BUT ESSENTIALLY PRACTICAL

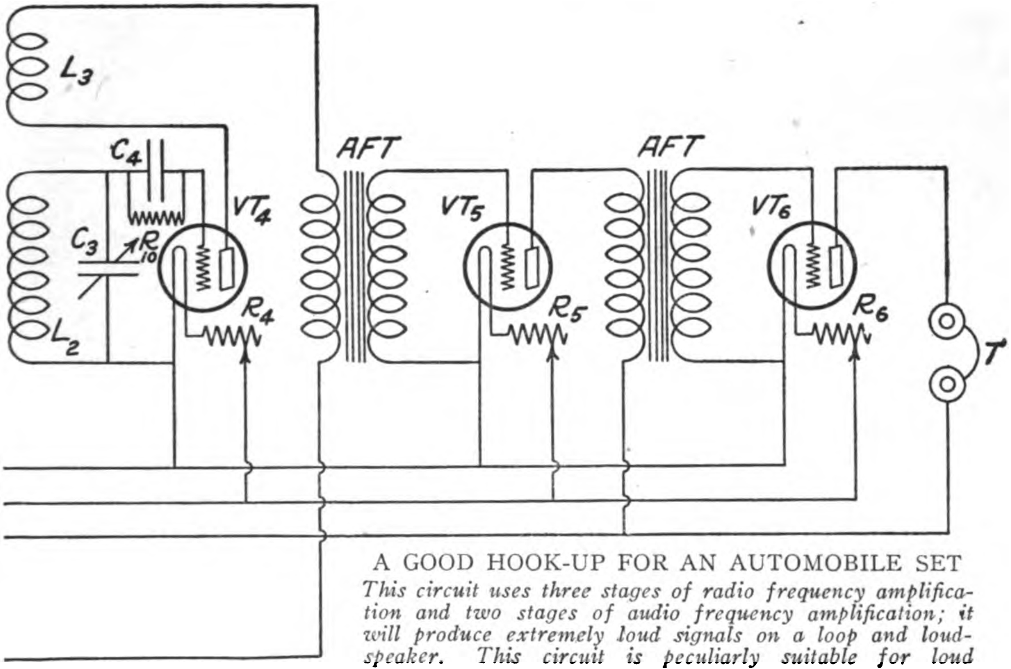
Here is a real antenna, easily dismantled, that A. H. Grebe, of New York, uses both for receiving and transmitting.



on the top of a closed car, such as shown in the illustration on page 249; note that the wires run in a horizontal plane, instead of vertically. This fixed arrangement makes the horizontal form of loop non-directional, or in other words, the antenna receives equally well from any direction. One obvious advantage of this feature is that it does not necessitate turning either the car or the loop for the best results. In order to get loud signals, the same type of receiver with radio frequency amplifiers is necessary as is required with the vertical loop. The horizontal type of antenna might be stitched into the cloth top of the car; in that case it would be invisible and out of the way.

A third type of antenna which seems to be the most popular of all with which amateurs experiment is the small flat-top antenna supported on short masts fore and aft. Such an outfit is illustrated in the illustration on page 249. This antenna functions in the same manner as the regular outdoor antenna generally used by amateurs, although on account of its abbreviated size it does not pick up as much energy as its larger cousin. With this antenna system it is necessary to use a ground; the latter is usually made by attaching the wires to the metal chassis of the car. Some of the large busses operated by a transit company in Oakland, California, have had this type of antenna installed; on account of the long bodies of the busses, it was necessary to use only a two-step amplifier set in order to produce good signals. In a short time all of the eighty-five busses of this service will be equipped with radio for the entertainment of the passengers.

A radio equipped motor car that is so elaborate and complete as to come outside of the classification of pleasure car has recently been built by the Chester County Radio Club in Pennsylvania. They purchased a five-ton truck and built upon it a special body in the shape of a regular radio shack, with all the equipment, both for sending and receiving, of a real radio station. Underneath the floor of the shack is fastened a large zinc plate which is used instead of a ground. The plate forms an effective counterpoise. This portable radio station (for it is really that rather than a touring car)



A GOOD HOOK-UP FOR AN AUTOMOBILE SET

This circuit uses three stages of radio frequency amplification and two stages of audio frequency amplification; it will produce extremely loud signals on a loop and loudspeaker. This circuit is peculiarly suitable for loud ***reception on an auto.***

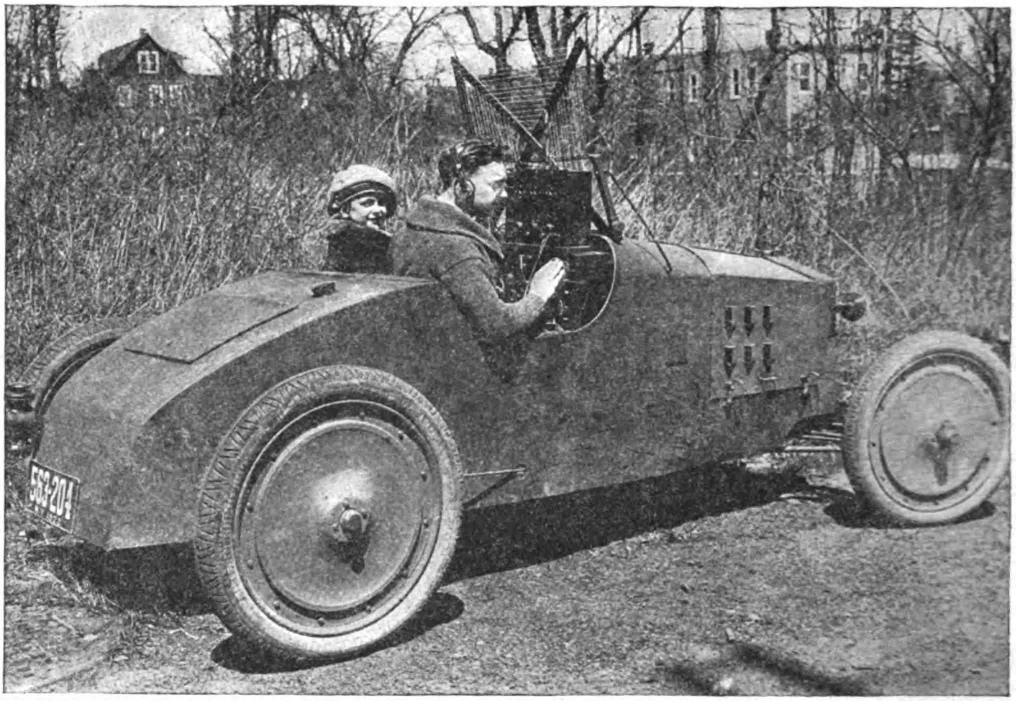
has a government license, and 3OI has been assigned as its official call number. The transmitting equipment consists of a 10-watt radiophone, the receiving set being of the two-step regenerative type. The receiving set of this remarkable machine has copied signals as far away as Indiana, Maine and Georgia.

A Chicago physician has installed a radio receiving set on his car, however, and adopted the same type of antenna. But his antenna is not fastened on masts, running over the top of his coupé instead on special insulating brackets, with the ends fastened on the radiator cap and the tire rack respectively. (See illustration on page 248.) The ground is made on the frame of the car.

One of the first men to do really constructive work in the installation of radio sets on pleasure cars is Al Grebe of Richmond Hill, Long Island. He installed a remarkably efficient antenna of this type, and then proceeded to include on board a transmitting set as well as a receiving set. Both the transmitting and the receiving experiments were very satisfactory. All of the electrical energy for the sets was furnished by the power plant of the car.

A fifth installation which is, in effect, a cross between the last two types of antennæ mentioned, is that employed by M. Phanto. With the use of multi-stage amplification this set can reproduce the broadcasting programs by means of a loudspeaker with such strength that the signals are audible more than a block away from the car. Even racing cars have been equipped with receiving sets to enable the driver to obtain information or instruction while on his dash around the track.

There is no doubt that radio on moving vehicles will be further developed to the point where it will not only be a novelty, but a convenience to the public, as well as a means of direct communication commercially from a company's office to its delivery wagons or trucks. Already radio installations are not unknown on government vehicles; the Army, the fire departments, the forestry service and the police departments are at the present time using radio successfully on their trucks and airplanes. In England the fire



Ewing Galloway

A BIG RECEIVER ON A LITTLE RUNABOUT

This fan, R. E. Leppert, Jr., of Harrison, New York, has shown ingenuity not only in installing a practical set on his car, but also in camouflaging his Ford!

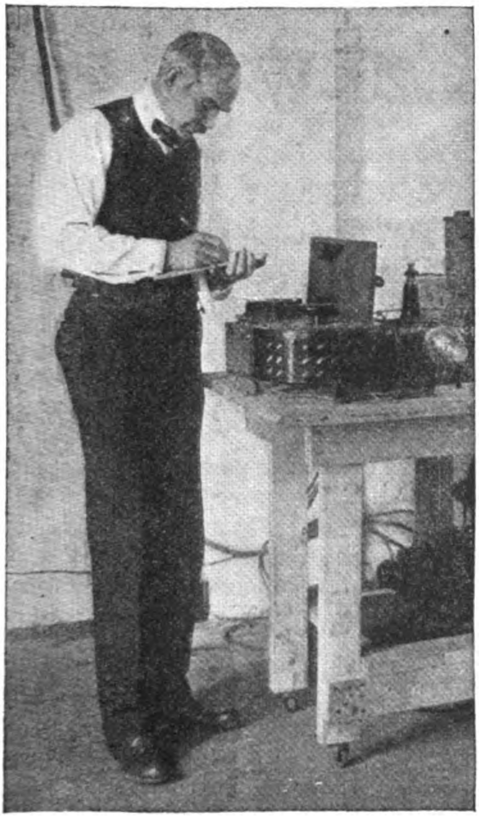
departments of some of the cities have been carrying on experiments to determine the value and usefulness of radio communication. Radio telephone transmitters and receivers have been installed on the trucks of a number of its fire brigades, and have proved effective in keeping the home station and the trucks in touch with each other in a way that has been impossible heretofore. The antenna system employed on the cars consists of a wire strung from a pole at the rear of the truck to any support that happens to be in the vicinity. Grounding of the apparatus is accomplished by means of throwing out two large wire-mesh mats which are attached to the set by means of insulated wires. Of course this system can be used only when the truck is motionless, but the increased length of the antenna adds so greatly to the range of the set that this disadvantage is said to be more than offset. The use of radio on commercial trucks is anticipated by a large baking company in Philadelphia, which has installed sets on its delivery trucks; among the purposes one is to direct the out-of-town delivery service.

The police are also using radio motor vans to deal with emergencies that arise in the handling of crowds during public demonstrations.

The motorized radio played quite a part in successfully dealing with the massed crowds during the last May Day demonstrations in Paris. Two large vans equipped with powerful transmitting and sensitive receiving sets were employed for this purpose; one was stationed at Chois Le Rois and the other in the yard of the prefecture, kept there for an emergency call. Both of these vans were in constant communication with each other; and a plane, also equipped with radio, reported any gathering of large crowds to the vans, who in turn issued instructions to the police of that district. The radio in this instance was a powerful instrument in the hands of the law, as it kept all districts under supervision of the prefecture in a way that would not have been considered possible a few years ago. The type of antenna used was a vertical two-wire affair, supported on a collapsible pole raised through the roof of the van.

Another novel use for radio on a touring car was developed in San Francisco a short time ago by the American Bible Society in "selling Bibles by radio." An auto which was equipped with a radio receiving set carried the voice of A. Wesley Mell, secretary of the Pacific agency, to the crowds that gathered around the car on its passage through the streets.

There is no doubt of the success of motorized radio. The uses to which this form can be put are increasing in number daily. On pleasure cars, however, the most convenient and probably the most efficient type of installation consists of a horizontal loop antenna stitched into the top of the car, with a receiver that uses radio frequency amplification and audio frequency amplification combined. Either the new Armstrong circuit or the circuit shown in Figure 1 would be suitable. The lighting batteries of the car may be used for heating the filaments; the only other batteries required are the "B" batteries. The set can be installed under the dash in front of the seat next to the driver, where it will be out of the way but accessible for adjustment. Such a set would hardly be noticeable in the car; yet its efficiency would enable very loud signals to be received by the use of the loudspeaker.



Paul Thompson

Radio Opens a New Era

To the Editor of Popular Radio:

"It is very gratifying to see someone taking the initiative in a broad-spirited public movement to enlarge the present scope of radio broadcasting. Certainly at the present stage of radio development there is a decided lack of public spirit manifested by those who should be the very ones to take the lead in this matter.

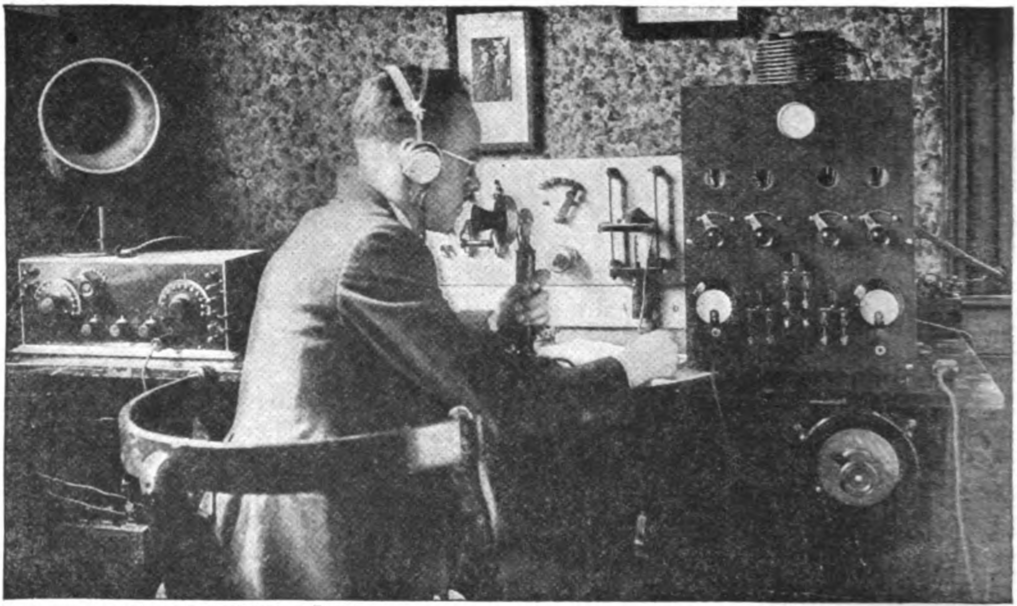
"The possibilities of radio broadcasting, long predicted, are now realized by all who are in any way associated with the engineering side of this new art; all that remains is the application, so that the present generation may enjoy the truly remarkable advantages heretofore retained by the few, but now to be had by the great mass of our population.

"All true lovers of music, all those who desire to extend educational opportunities to the many, government officials who are interested in helping to enrich the lives of many millions—one and all, I believe, owe it not only to themselves but to humanity in general to see that the best in art, education, literature and music is put at the disposal of all those who make up the major part of our nation.

"As one who has long had in view the application of the radio art to the definite field of music, education, art and literature, I am frankly glad to see you enter the lists on behalf of the public."

Lee de Forest

Inventor and Scientist



From a photograph made for POPULAR RADIO

THE AMATEUR WHO DID IT

This is W. K. Thomas. At his right is the transmitter, with the receiver at his left. An ordinary desk telephone microphone is used to talk into, and it is attached to the transmitter, while the telephones on the operator's head are attached to the receiver. The large switch near the operator's hand is used to change from sending to receiving. The completeness of this station typifies the advance of the amateur in radio.

6,000 Miles on 20 Watts

The Remarkable Radio Apparatus Operated by 8LF that Has Made Possible Some of His Notable Achievements

By RICHARD LORD

ON the night of November 6, 1921, radio operator Farmer, on board the steamship *West Prospect,* 2,750 miles west of San Francisco, picked up continuous wave signals from a radio amateur who signed off "8LF." Investigation revealed the amazing fact that in real life 8LF is W. K. Thomas, who lives in Pittsburgh—6,000 miles distant from the remote spot in the Pacific where his signals were recorded on that notable evening.

This achievement is made hardly less remarkable by the knowledge that Mr. Thomas employed a telegraph-telephone transmitter of only 20-watts power. For the benefit of the lay reader, it may be explained that 20 watts represents only about 40 per cent. of the electric power required to operate the ordinary incandescent lamp.

Despite its modest power, however, the Thomas set has proved of remarkable efficiency in long distance transmission. On the night of April 19, 1921, it carried on communication with the Catalina Islands, California, a distance of about 3,000 miles. Nightly communication has been carried on over distances ranging between 300 and 1,200 miles. The voice (antenna current 1 ampere), with two oscillators and two modulators, has been heard as far south as Orlando, Florida, as far east as Philadelphia, as far north as Michigan and as far west as Kearney, Nebraska. A few years ago 8LF was using a 1 K.W. spark transmitter with an input to the antenna of 246 watts; on the C.W. set (the same set as is described here), the total input is 46.8 watts. Six times the distance has been covered with 200 watts less input. Efficiency on the spark transmitter was about 12 percent and on C.W. nearly 60 percent.

A detailed description of this set is of more than casual interest to the amateur.

The antenna system is composed of six parallel wires spaced 3 feet apart and 65 feet long, suspended at the far end on a ship mast affair on top of a telegraph pole, planted in the rear of the residence. The other end is supported by a mast on top of the house, both 45 feet above the ground. This antenna system has a low natural period and also low resistance, operating most efficiently at approximately 200 meters.

All panels are made of ¼-inch bakelite. The front panel is 14 inches by 18 inches, the main shelf 10 inches by 14 inches and the sub-shelf is 4 inches by 14 inches. Mounted on the main panel is an antenna meter in the center (at the top). Holes 1½ inches in diameter are drilled for peep holes for each tube, and as the shelf is mounted on micarta uprights 10 inches from the top of the main panel, the alignment of the holes should be such as to permit a proper vision of the active elements of the tubes, plate, grid, and filament. The rheostats for the filaments are mounted under each peep hole.

The general position of all knife switches is shown in Figure A. Two

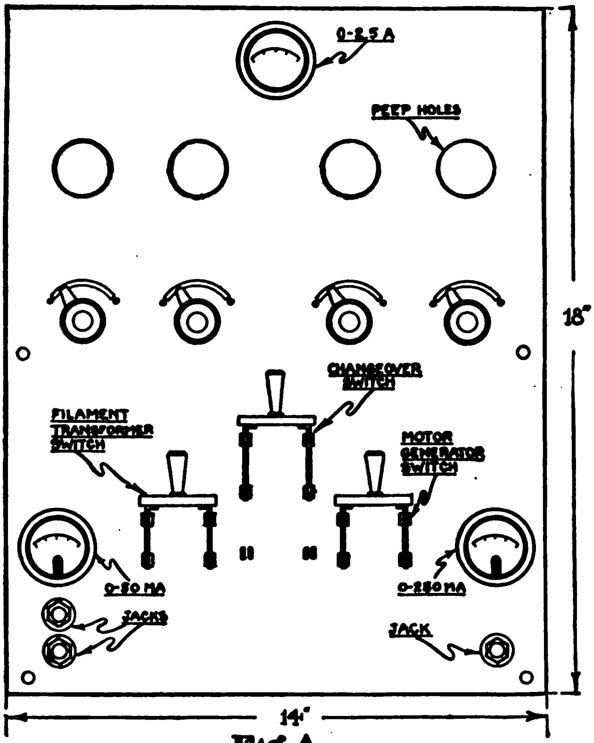
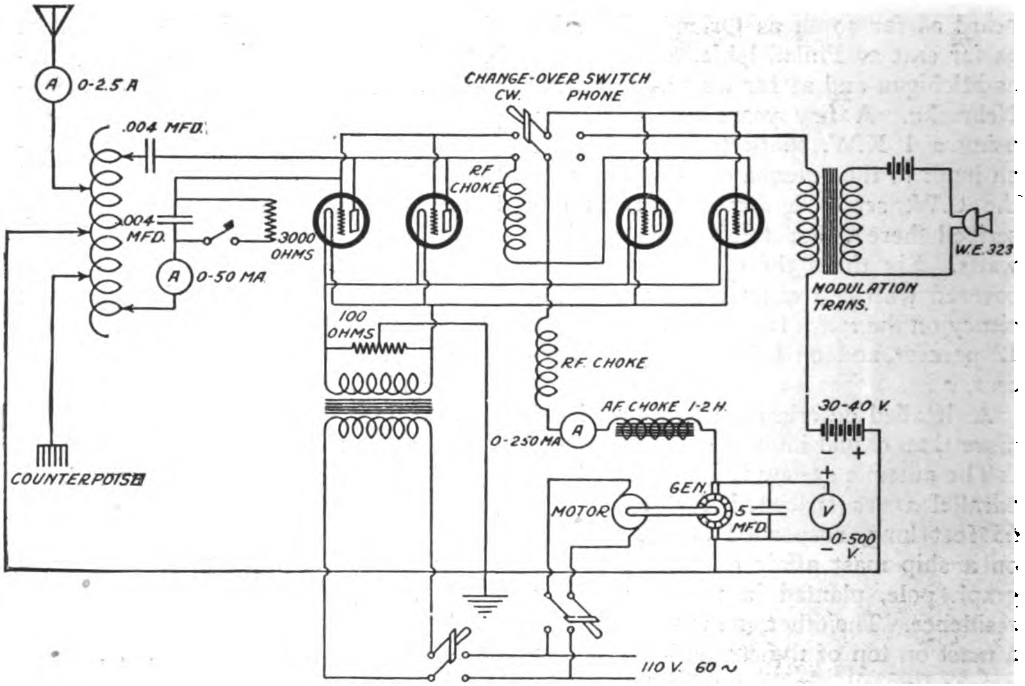


Fig. A

This diagram shows the layout for the front panel of the transmitting apparatus illustrated on the opposite page.



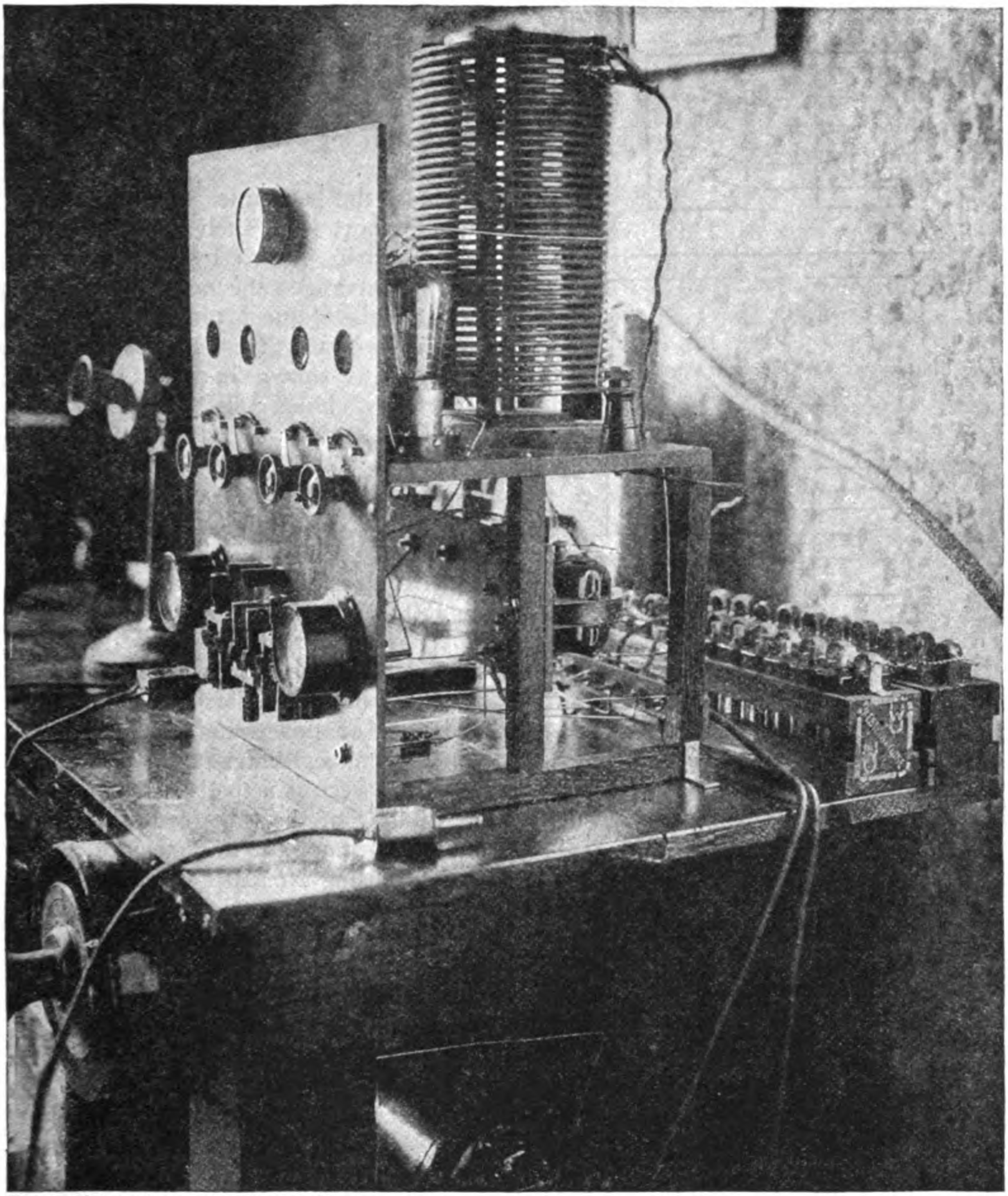
THE WIRING DIAGRAM OF THE THOMAS SET

Circuit diagram for 4-5 watt tubes, using Heising modulation for voice. The tube filaments are heated by a step-down transformer operated off the 110-volt A.C. lines. The motor-generator, which supplies the high-voltage direct current for the plate circuit of the tubes, is also operated from the same power source. A switch is provided for using all four tubes as oscillators, for C.W. telegraphy—in which case the telegraph key in the grid circuit is used in forming the code characters.

milliammeters should be incorporated in the set—one to register the grid current (full scale deflection 50 milliamperes) and another to register the total plate current (full scale deflection 250 milliamperes). Three jacks and two plugs are used. With this arrangement the use of but one telegraph key is necessary. One of the plugs is connected to the key, which, when plugged into the upper jack on the lower left-hand side of the panel, will make and break the 6-volt circuit to the buzzer and when plugged into the right-hand jack on the panel will make and break the grid leak circuit for continuous wave transmission. The other jack is connected to the modulation transformer. The microphone is connected to another plug which should be inserted in the lower left-hand jack.

On the main shelf are mounted four sockets and the inductance coil and the buzzer. The inductance is 7 inches in diameter and 9½ inches high; it is wound with No. 10 bare copper wire, 35 turns ¼ inch apart. The wire is wound into grooves cut in the bakelite uprights and fastened securely at both ends. The builder can readily devise some sort of suitable connection clip for No. 10 wire.

On the small sub-panel placed under and parallel with the main panel and mounted on another set of brackets are the modulation transformer, grid condenser, grid leak, plate condenser, audio frequency choke coil and two radio frequency choke coils. The grid condenser is made up of seven pieces of copper foil .002 inches by 1½ inches by 2½ inches, as conductors, with thin strips of mica as dielectric, pressed and immersed in boiling paraffine. For the grid leak a Ward-Leonard resistance tube of from 3000 to 5000 ohms resistance is used. The plate



From a photograph made for POPULAR RADIO

A CLOSE-UP OF THE THOMAS TRANSMITTER

This is the apparatus on which 8LF has communicated from his home in Pittsburgh to stations as far west as 2,750 miles off the Pacific Coast. This view of the set gives a comprehensive idea of the general assembly of the panels and the bracket supports. The oscillation transformer and tubes are mounted on the shelf, and the modulation transformer and choke coils are fastened to the back panel. The binding post strip is also shown attached to the two rear wooden supports.

condenser is a .25 mfd. condenser, but any condenser that will stand the plate voltage is suitable; in fact, a duplicate of the grid condenser will be entirely satisfactory. This condenser prevents a short on the generator in case the antenna

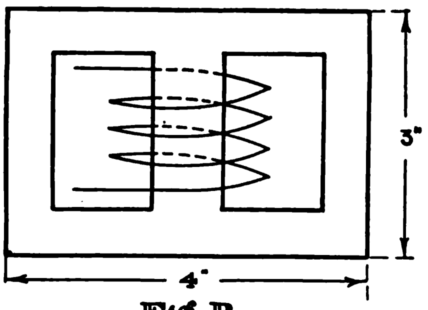


FIG. B

The dimensions for the iron core of the audio frequency choke coil.

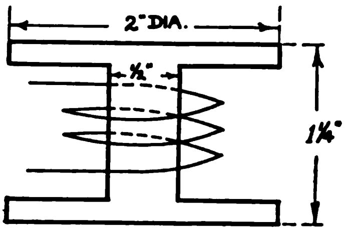


FIG. C

Dimensions for the wooden spools upon which the radio frequency choke coils are wound.

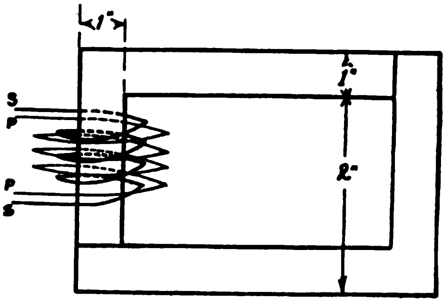


FIG. E

Dimensions of the iron core for the filament lighting transformer.

should accidentally become grounded.

The audio frequency choke coil is made up of approximately 3,000 turns of No. 30 DSC wire wound on a micarta square tube that fits snugly over the center leg of iron punchings, the dimensions of which are shown in Figure B. Both of the radio frequency choke coils are wound on micarta spools, the dimensions of which are shown in Figure C; they should be wound full with No. 30 DSC. These spools do not necessarily have to be made of micarta, but may be constructed of cigar box wood treated with paraffine.

Across the back micarta uprights that help support the shelves is bolted a micarta strip 1 inch by 14 inches, on which is arranged the necessary binding posts for the filament, plate, grid, buzzer, and microphone current supply; they are arranged as shown in Figure D. All condensers, choke coils, filament heating transformers and other parts are available on the market.

Experiments have been made with various sources of plate supply; the most satisfactory is the motor-generator, which is a direct-coupled affair, delivering 150 watts at 400 volts. The filament supply is obtained by stepping down the 110-volt, 60-cycle current to 7 to 8 volts by means of a transformer. Across the secondary of this transformer is a 100 ohm resistance, center-tapped to obtain the same effect as actually center-tapping the winding of the transformer. A suitable transformer for this purpose can be made by using No. 10 DCC wire as the secondary with 32 turns and No. 22 DCC as the primary with 400 to 440 turns, tapped for variation of voltage. The secondary winding is placed nearest the core, being wound on a square tube, 2½ inches long, and the primary winding is placed directly over this winding, the core being assembled in a square "O" shape. There are so many suitable transformers on the market for this purpose that anyone who is unable to obtain satisfactory punchings for the core would hardly be justified in attempting to construct it; however, Figure 3 shows a transformer that is suitable for supplying one to five tubes with current for operation. A 1,000-volt, 5 mfd. condenser should be placed across the generator or plate supply and one audio-frequency choke coil connected in series with the generator. This forms an effi-

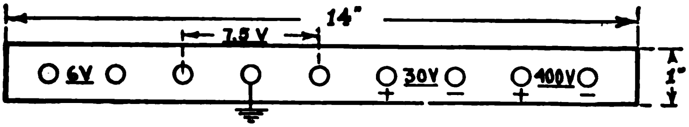


FIG. D

Diagram of the strip of micarta upon which the binding posts for the battery connections are mounted.

cient filter for doing away with the commutator ripple.

The entire set is wired with No. 14 solid bare copper wire in accordance with the diagram shown in Figure F; with proper care in wiring, and assuming that the antenna system is suitable, the antenna current should be approximately 2.5 amperes, using four tubes as oscillators on 200 meters. For transmitting the voice, two tubes should be used as oscillators and two tubes as modulators; the antenna current should be 1 ampere or more.

Any amateur who builds a set from this description will presumably attain results similar to Mr. Thomas'—providing, of course, that his antenna system is adequate and that the local conditions are favorable.

¶ How many radio fans know just what is the difference between a "hard" tube and a "soft" tube? How many know the specific uses for which each is designed? In the next issue of this magazine—JANUARY—Prof. William C. Ballard, Jr., of Cornell University, will answer these questions; incidentally he will give the amateur other information of practical helpfulness.

Radio as a Power for Educating the People

TO THE EDITOR OF POPULAR RADIO:

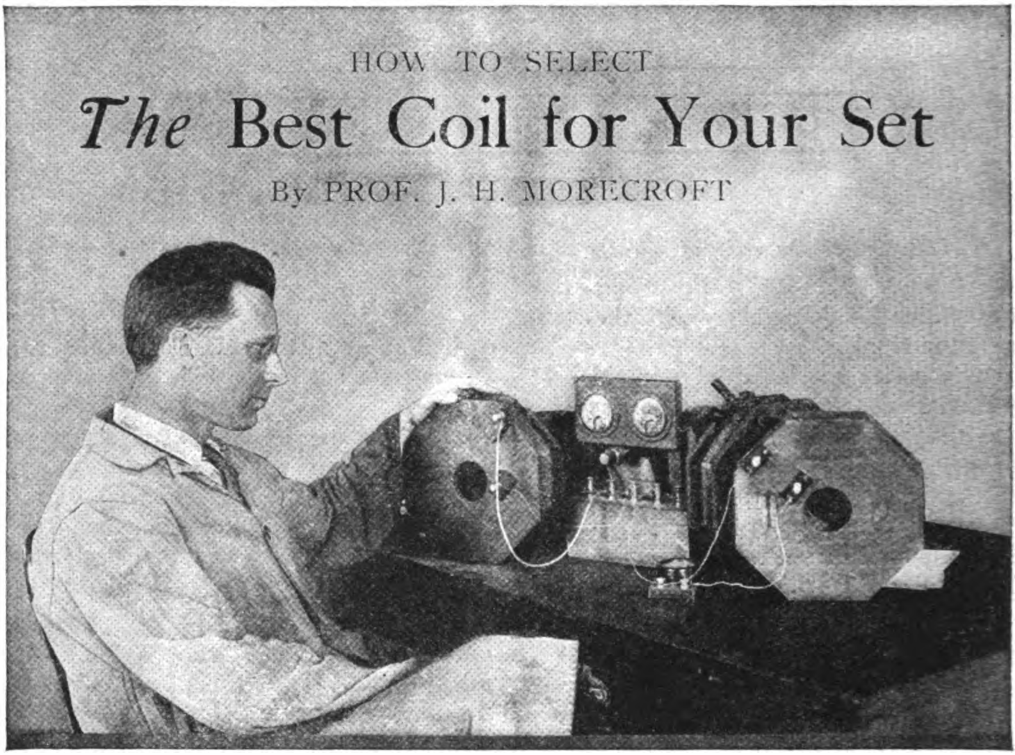
"It seems to me that there are undreamed-of possibilities for the utilization of radio broadcasting in the interest of educating the public. I think the mistake is too frequently made of thinking that education can be secured only through formal institutions of learning. Of course, the fact is that any open-minded individual is becoming more educated all the time simply by the use which he makes of the accessible opportunities of life; and many a man of acquisitive mind acquires a better education by himself than many another does, even with the assistance of one of our foremost colleges or universities. If a broadcasting program could be devised and made available under the guidance and direction of a group of men free from any suspicion of pleading for special causes, it would be a tremendously valuable contribution to raising the general level of intelligence and culture."

President of Dartmouth College

HOW TO SELECT

The Best Coil for Your Set

By PROF. J. H. MORECROFT



From a photograph made for POPULAR RADIO

In this article the author, who is one of the foremost radio experts in the country and a member of the faculty of Columbia University, tells the radio amateur what his coil really does and points out how he may determine the particular kind that will best serve his particular purpose.

IT would seem that such a simple thing as a coil could require but little analysis; that anyone could build a coil which would prove satisfactory when used in a radio circuit. Of course anyone *can* build a coil which will operate in a radio circuit; the question is—how good is the coil and how well will it operate compared with the best coil which can be built for the purpose?

It is the purpose of this article to point out some of the factors which determine just how good a coil is and how well it should function.

There are three so-called electrical constants which enter into all of our calculations in radio work; not only enter into our calculations but which also determine completely how well a set may operate. They are:

The inductance;
The capacity;
The resistance.

Resonance is, of course, the key-note of operation of all radio circuits; the product of the inductance and capacitance used in the circuit determine at what frequency resonance is obtained. The sharpness of this resonance (that is, the relative ease with which it lets through the desired frequency as compared with others of different frequencies not desired) is determined by the ratio of the resistance of the circuit to its inductance.

It is evident that the characteristics of a coil, simple thing as it is, are well worth while studying; this study soon shows that resistance and inductance at radio frequencies are not the simple things taught in elementary physics, but are rather complicated—so much so that theory alone cannot predict what the constants of a coil will be at high frequencies, so that recourse must be had to experimental determination.

The student of electricity learns that if the voltage (in volts) of a continuous current circuit is divided by the current (in amperes) which flows through a circuit, the quotient will be the resistance of the circuit (in ohms), and that this resistance is constant unless the temperature changes. In an alternating current circuit the same quotient yields the impedance of the circuit, the impedance being made up of two components, resistance and reactance. If the current lags behind the voltage, in phase, the reactance is inductive; if the current leads, it is capacitive. The resistance of the circuit is not the same value at all as would be determined by continuous current test, using Ohm's law for its calculation; in fact, a circuit which shows millions of ohms resistance to continuous current flow may have only a fraction of one ohm for a high frequency alternating current.

As Ohm's law does not suffice to determine resistance in an alternating current circuit we must get a new definition which does meet the situation. This definition, which is applicable to all circuits for continuous as well as for alternating current (that is, it includes Ohm's

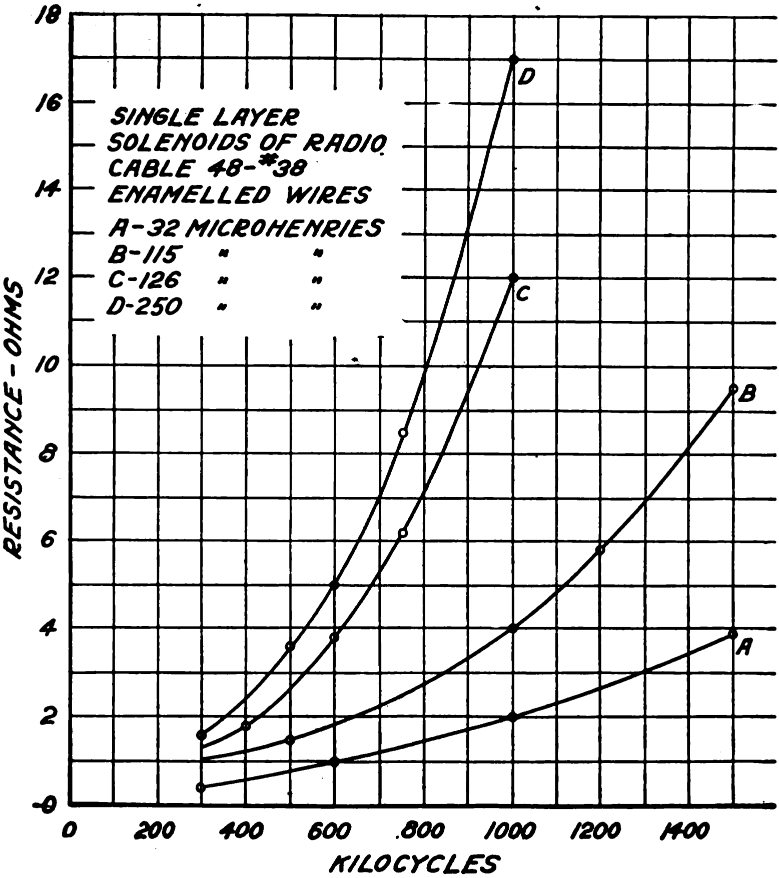


FIGURE 1

A resistance-frequency chart of single layer solenoids of different values of inductance.

law as a special case) is

$$\text{Resistance} = \frac{\text{Power used in the circuit}}{(\text{current flowing in the circuit})^2}$$

If the power is given in watts, and the current in amperes, the resistance will come out in ohms.

It might be questioned how this definition can be used in radio circuits—can we use a watt-meter to read the power used? The answer is "no"; the procedure indicated by the definition does determine the resistance but is not generally followed. We could put the circuit in a calorimeter, measuring the rate at which heat is developed, divide the amount of this heat by the square of the measured value of the current flowing, and so determine the resistance; but such a method is not suitable for rapid and accurate determinations.

It is possible to so adjust the circuit that its reactance is zero, in which case the resistance is given by Ohm's law.

$$R = E/I$$

In another method the alternating current Wheatstone bridge is used, by which the resistance and reactance of the coil are both determined at once when the bridge is balanced. The bridge is probably not accurate however at more than a few hundred thousand cycles a second so that the resonance method (making the reactance equal to zero) is the only one available.

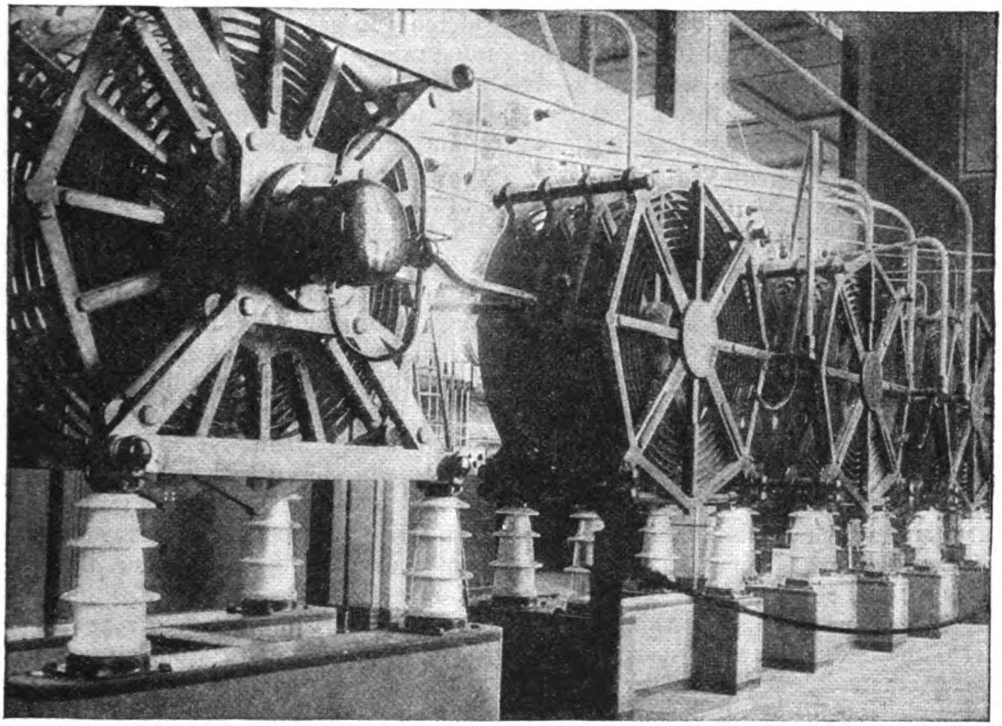
If the frequency of the power supply is known (as it will be by wavemeter determination) and the capacity used in the circuit to establish resonance is accurately known, the inductance of the coil, as well as its resistance, is determined by the resonance test. So with a good wavemeter, and a well built and carefully calibrated condenser, with suitable thermocouples for current measurement, resistance and inductance measurements may be made with a fair degree of accuracy for frequencies as high as ten million or more.

This article gives the results of a few measurements made by the writer in such a fashion; from these results certain conclusions may be drawn which are interesting to the radio enthusiast. By the radio enthusiast is meant the one who is interested in knowing *why* certain things are as they are, not the one who merely boasts that he furnishes the neighborhood with so much noise from his set that the police department have to censor him, or the one who hears so many distant stations that actually do not exist. Recently the writer received two letters from the enthusiastic West giving in detail conversations which some amateur had heard over his phone set; these conversations took place when the transmitting station was closed tight under lock and key.

Why should the resistance of a coil be different at radio frequencies than for continuous current?

There are many things resulting in an increase in resistance for the high frequency alternating current which do not exist at all for continuous current or very low frequency alternating current. For continuous current all of the cross-sectional area of the conductor is useful in carrying current, whereas for high frequency, due to what is called the skin effect, but a small part of the copper may be useful in carrying current. The losses in bits of metal used in the construction of the coil (for terminals, for example) change the effective resistance of the coil, always making it greater than it is for continuous current. The material on which the coil is wound is in a high frequency electric field, and even though it be a perfect insulator, permitting no current at all to leak from one turn of the coil to the next, it is subject to losses called "dielectric losses," or "dielectric hysteresis." This loss increases directly in proportion to the frequency and so may give a substantial increase in the effective resistance of the coil at the high frequencies used in radio.

It might be thought that this change in effective resistance with increase of



International

GIANT LOADING COILS IN THE RADIO STATION AT NAUEN, GERMANY

The amateur, who deals with electrical powers which are infinitesimal in comparison to those used for trans-oceanic telegraphy, should be careful to use coils that will squeeze out into the antenna even that last little fraction of a watt that is trying to find a small hole to sneak into and peacefully sleep, instead of being shot out into cold space

frequency is not worth bothering about—perhaps a few per cent. But such is not the case; the resistance for high frequency alternating current may be many times as much as it is for continuous current. Thus one coil such as might be used in an ordinary receiving set had a continuous current resistance of 0.45 ohms; at 500 meters wavelength it had 3.5 ohms, and at 200 meters it had 18 ohms. In other words, the coil had forty times as much resistance as the wire table for resistance of copper wires would predict. This was not a defective coil, but a good single layer solenoid of No. 20 solid copper wire.

To show how the resistance of coils varies with frequency the curves of Figure 1 are given; they are experimentally determined curves for ordinary solenoids such as are used in receiving sets of the better class. The wire of which the coils were made was of radio cable, made of 48 strands of No. 38 enameled copper wires properly bunched together. Up to frequencies above one million cycles a second the cable shows itself superior to solid wire, as the solid wire has not the same cross section as the cable but is of such a size that it winds the same number of turns to the inch. The continuous current resistance of the solid wire was only about one-half as much as that of the cable, showing there was more copper in it than there was in the cable. Above one million cycles, however, the solid wire actually becomes better than the much more expensive cable, or "litzendraht," as it is sometimes called.

The superiority of the solid wire is well shown in Figure 2, which gives the resistance of solid wire and cable coils of the proper number of turns to make them suitable for short wave sets. It will be seen that at the higher frequencies the solid wire has less resistance than the cable, although at the frequency used in broadcasting (about 833,000 cycles) the cable is considerably the better of the two. As to just where the solid wire becomes better than the cable will depend somewhat upon the form of coil; the conclusions reached from these curves holds only for coils of similar shape and method of winding. It is comforting for the amateur who "builds his own" to know that the cable, costing about twenty times as much as the solid wire, and which is also troublesome to tap, is but little better than the cheap, easily worked solid wire.

For a given type coil, wound of a given kind of wire, at a specified frequency, there is one coil which gives a better performance than one with either more or less turns; that coil having the greatest ratio of reactance to resistance will tune best, be most selective; to get this highest ratio a coil with the proper number of turns must be used.

Using two and three layer banked winding solenoids, made of radio cable (48-38's), the ratio of reactance to resistance was found for various coils as given in Figure 3. The coils were all of the same diameter (about 4 inches), and the length varied with the number of turns used. These curves indicate that to get the best tuning (greatest selectivity) a proper coil should be used for a certain wavelength. Thus, for tuning to 500 meters we should use coil A in preference to any of the others, but for 800 meters practically all of the coils are equally good. It must be borne in mind that the conclusions drawn from these curves, while in general correct for any form or type of coil, hold specifically true only for coils of this size and wound with the kind of wire used here; also that the losses in the condenser used in conjunction with the coil for tuning must be considered. In general if two coils have the same ratio of reactance to resistance, that with the smaller inductance is preferable, as it will require a greater capacity for tuning and the effective resistance of a variable condenser always decreases with increase of capacity.

The resistance of the loading coils used in transmitting sets is an extremely important factor in the efficiency of the station. Unfortunately the requirements for tuning, as at present carried out, practically require that a coil of heavy copper strip be used so that clips can be moved along them for adjusting the wavelength. The resistance of these coils is excessively high at radio frequencies. In one coil of heavy copper strip measured by the writer the resistance at 3000 meters was 350 times as much as its continuous current resistance; at 200 meters it would have been thousands of times as great as one would think, looking at the amount of copper used. In a certain one-kilowatt transmitting station the loading coil got so hot that it was uncomfortable to touch; it seems likely that two or three hundred watts were being used up in this coil, an amount of power which required an investment of perhaps $200 in tubes to generate. It seems advisable to build the loading coil of heavy radio cable, of the proper number of turns to tune the antenna to a slightly lower wavelength than it is desired to radiate, and bring the circuit up to the desired wavelength by putting a good variable condenser in parallel with the antenna. If the loading coil of your transmitter gets appreciably hot it is a safe guess that the coil has a very high resistance and is inefficient.

The coefficient of self-induction of a coil may be easily calculated when the dimensions of the coil and number of turns are given. If the coil is measured at, say, 1000 cycles the calculated value of L will be found the same as the measured value, generally closer than 1 per cent. If, however, the coil is measured at radio frequency the inductance may be

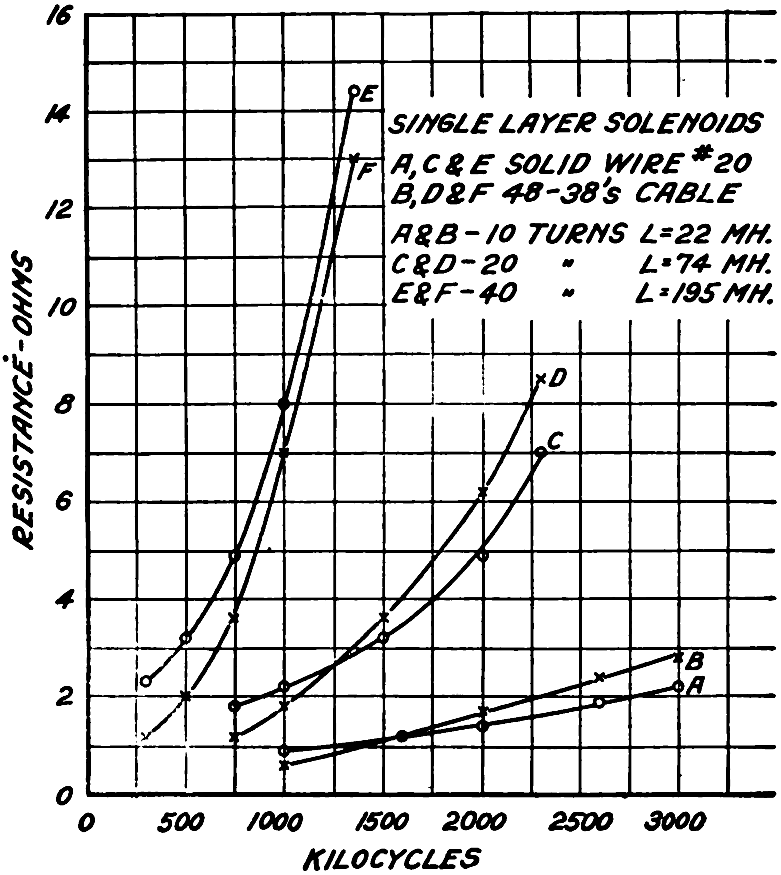


FIGURE 2

Another resistance-frequency curve for coils wound with No. 20 wire.

found either slightly less or considerably more than the measured value. And in the extreme case what is evidently a coil measures up as a condenser!

The reason that the measured value of L may come out smaller than the calculated value is because of the shift of the current from a more or less uniform distribution throughout the cross-section of the wire at the low frequency, to a crowding to that side of the wire which is closer to the axis of the coil at radio frequencies. As this shift in the current is equivalent to a decrease in the radius of the coil, of course the measured value of L is smaller than the calculated one, as the formula assumes a uniform distribution of current. If radio cable is used in constructing the coil this effect cannot occur, so the value of L does not show a decrease as the frequency is raised; the effect occurs to the greatest extent in the strip coils used for transmitting loading coils.

The apparent increase in inductance with increase in frequency exists in all coils, no matter how they may be built, and does result in an increase in the measured value of L at the higher frequencies, no matter with what kind of wire the coil is wound. In the solid wire, or copper strip coil, therefore, we may expect the inductance to decrease slightly at first as the frequency is raised and then to increase, whereas with cable wound coils the measured value of L will show a continual increase in L as the frequency is raised. This increase

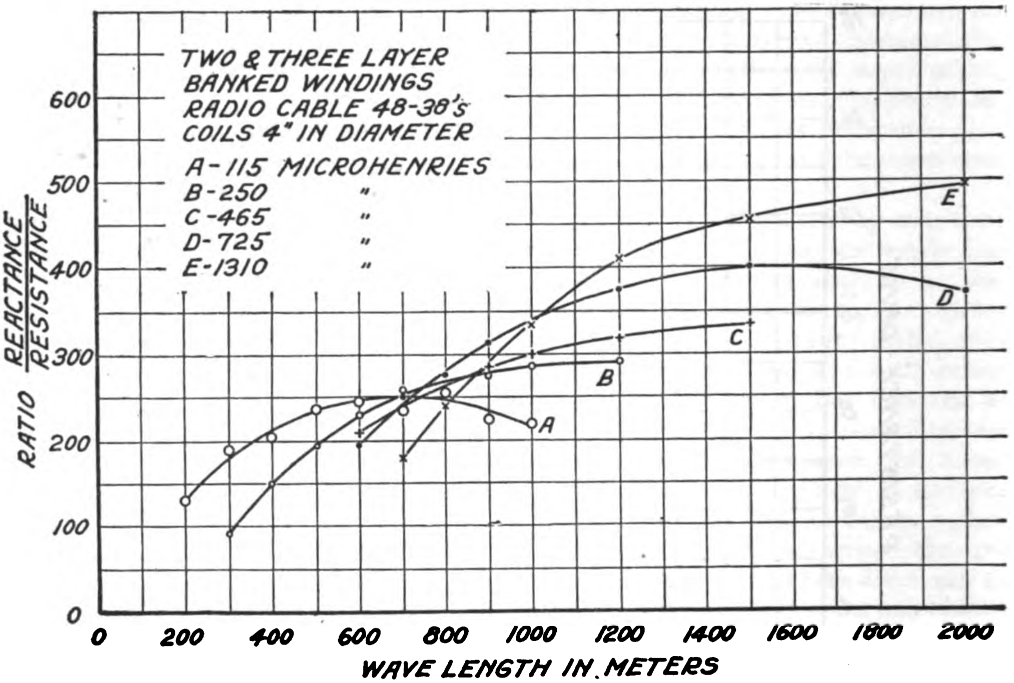


FIGURE 3

This chart shows the ratio of reactance to resistance for two and three layer bank-wound coils at different wavelengths.

is due to the distributed capacity of the coil itself. Each part of the coil acts with every other part to form a kind of complicated condenser, so that the coil really should be represented as a coil in parallel with a fixed condenser, the capacity of this condenser being equal to the distributed capacity of the coil. This representation is not complete because actually the capacity of the coil changes with frequency, an effect which is generally neglected in treating the theory of coils.

The effect of this distributed capacity is, in general, not detrimental, but may be so if the capacity is comparable to that used with the coil for tuning purposes. In this case, as the capacity of the external condenser is only a part of the total effective capacity in the circuit, variation of its value does not accomplish tuning as sharply as if there were no capacity of the coil affecting the circuit.

It might seem that distributed capacity in a coil is not objectionable, as we have to have a condenser connected to the coil anyway—for tuning purposes. But such is not the case. It is best to keep this capacity as small as possible because the dielectric used in that capacity is poor compared to the dielectric used in the external condenser. The distributed capacity of the coil has cotton, paper, shellac, or enamel, for its dielectric, whereas the regulation tuning condenser is a very well built air condenser, and air is far superior to any other substance as a dielectric; it has no losses at all.

The various turns and layers of a coil should be kept reasonably far apart if the distributed capacity is to be kept low, and the dielectric between layers and turns should be air, if possible. Several years ago the writer showed how such a construction could be carried out without too much difficulty. Using air for the dielectric between layers has the double advantage of low specific inductive capacity and also prevents leakage of current in passing from one layer of the coil to another.

Many times a solenoid is furnished with many taps and a multipoint switch for tuning purposes; although this is a convenience it does not give as good results as a single coil of the proper number of turns. This is especially true if but a small fraction of the coil is to be used, say a quarter or less. In such cases the coil acts as an auto-transformer, the unused portion having comparatively high voltages induced in it and thus producing large unnecessary copper and dielectric losses in the unused portions. Also it is evident that the switch points mounted in the panel of bakelite or similar material constitute a condenser in parallel with the tuning condenser; in this connection it should be borne in mind that losses in the bakelite, or leakage across from one point to another, is, of course, just as detrimental as leakage in the coil itself.

To prevent the losses in the unused portion of the coil it is best to build the coil in sections, an inch or more apart; many times it will be found advantageous to short-circuit that part of the coil which is not being used. This is especially true when but a small part of the coil is being used. Although there will be eddy current losses in the short-circuited part of the coil these losses may be less than if the coil were not shorted. There will be practically no dielectric losses in the unused parts of the coil, because the voltage in these parts will be low; and furthermore it is quite possible that there will be less current in the unused part than if it were not shorted, strange as this may sound. If there are several sections in the unused portion of the coil it will not be necessary to short all of the unused part; shorting the section directly next to that part of the coil which is being used is, in practically all cases, almost as satisfactory and as a matter of fact it is in general easier to accomplish.

George Grantham Bain

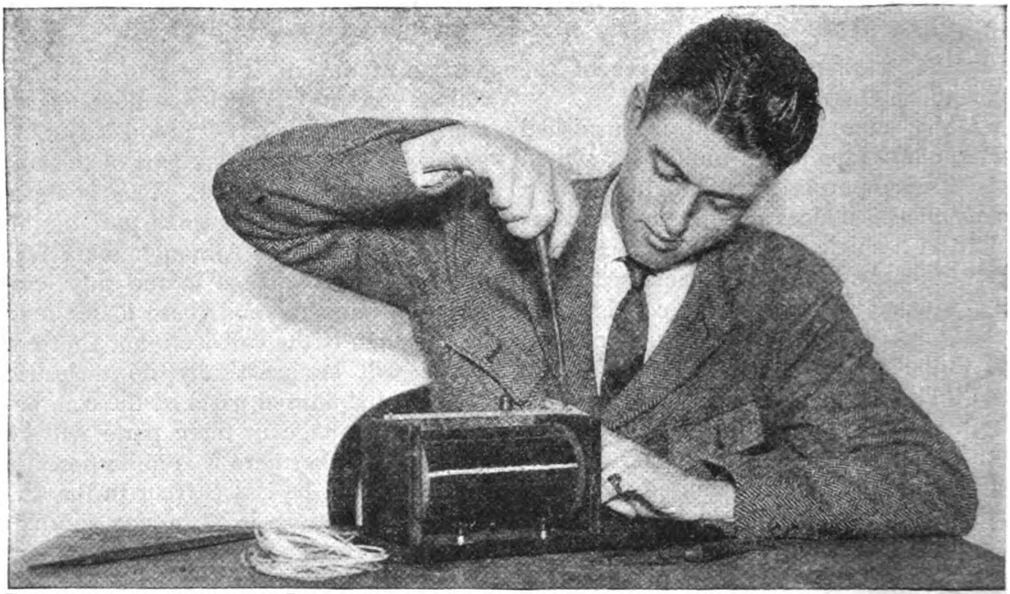
Radio's Chance to Render a Distinguished Public Service

To the Editor of Popular Radio:

"I entirely approve of your plan of extending the radio broadcasting program for educational and cultural purposes. It is a forward step in our civilization and the commencement of a very important movement to give the world at large a chance to participate in entertainments, instruction, musical programs and lectures, which heretofore could only be given to a comparatively small number, being limited to the space which could be given the audience in a building. By now being broadcasted they are opened up to a large public all over the world; in fact, to whoever wants to take advantage of the opportunity offered."

Adolph Lewisohn

Donor of the Stadium of the College of the City of New York



From a photograph made for POPULAR RADIO

THIS HOME-MADE SLIDING COIL COST 50 CENTS

A loading coil may be made either with a sliding contact for adjustment or the coil may be tapped. The coil described in this article is of the latter type.

How to Make and Use A LOADING COIL

The Seventh of the Popular Series of "How to Make" Articles for the Radio Novice

By A. HYATT VERRILL

FEW of the more simple devices used in radio telephony are less understood and less appreciated by the average novice or beginner than the loading coils. In the columns of questions and answers in the radio periodicals a large proportion of the queries seek information about the distance at which a set can receive and the use of loading coils to bring in signals.

The idea that the use of a loading coil will increase the distance at which a set can bring in signals appears firmly fixed in the minds of many radio fans who apparently do not understand that wavelength and distance have very little to do with each other. The wavelength is merely the length of the radio wave, and the shortest wave may travel completely around the earth, although it might not be possible to detect it with the instruments we now have. On the other hand, the best of sets might not pick up an extremely long wave message, even though the set were within a couple of miles of the sending station; whether or not a wave of a certain length is received depends as much upon the wavelength range of the set as upon its distance from a sending station.

Also, if the set can be tuned or adjusted to the desired wavelength the distance at which it can bring them in depends entirely upon its sensitiveness

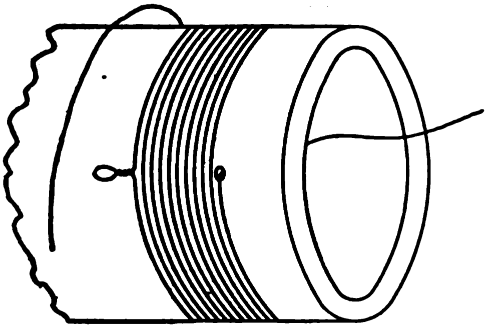


FIGURE 1
This diagram shows how a tap is made.

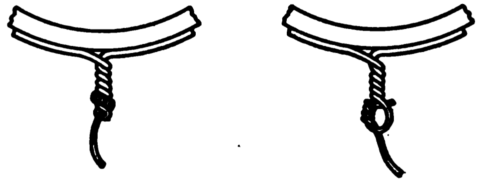


FIGURE 2
How a connecting wire is joined to a tap. The wire is twisted around one side of the loop and then the whole is twisted together.

and has nothing to do with the wavelength.

Hence the novice should remember that when he adds a loading coil to his set it merely increases the wavelength or the size of waves which can be received and does not increase the distance at which a signal may be received. It must also be borne in mind that different types or forms of loading coils must be employed with different types of sets. If you are using a set with a single circuit and a simple inductance, a single primary coil loading coil may be used. If you are using a double circuit set with a primary and secondary or coupled inductance then to obtain the best results the loading coil must also be a double or coupled coil.

A loading coil in effect is simply an extension of the aerial circuit; by adding it to your set you merely increase the wavelength of your aerial circuit by adding to the inductance already in the set. Loading coils also are made in various forms. Some of them are of large diameter and narrow surface; others are long and cylindrical. The latter form is the simpler to make.

Also, the longer the loading coil and the more turns of wire upon it the greater the wavelengths which may be brought in. As few amateurs wish to pick up the very longest waves, however, a coil which will bring in waves up to 5,000 meters is amply sufficient.

To make such loading coil—to be used with a single circuit set—is a simple matter; an excellent coil may be constructed at a cost of far less than you would pay for a ready-made coil. No special tools are required and the materials needed are few and inexpensive.

For a coil to load up to about 4,000 meters you will need a tube of formica or some similar composition, about one foot in length and four inches in diame-

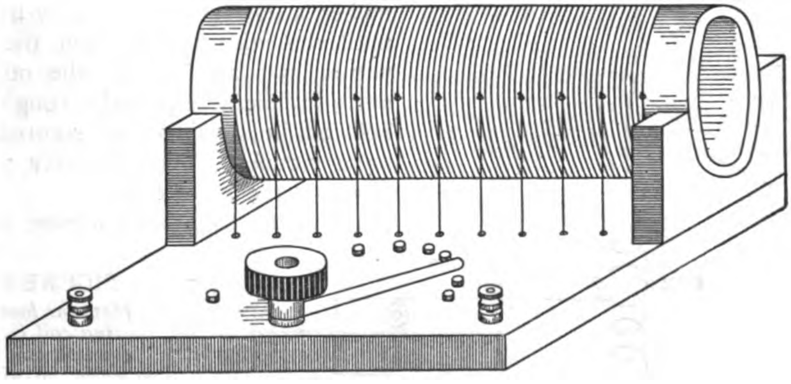


FIGURE 3
This is how the completed coil looks when it is mounted on a base-board.

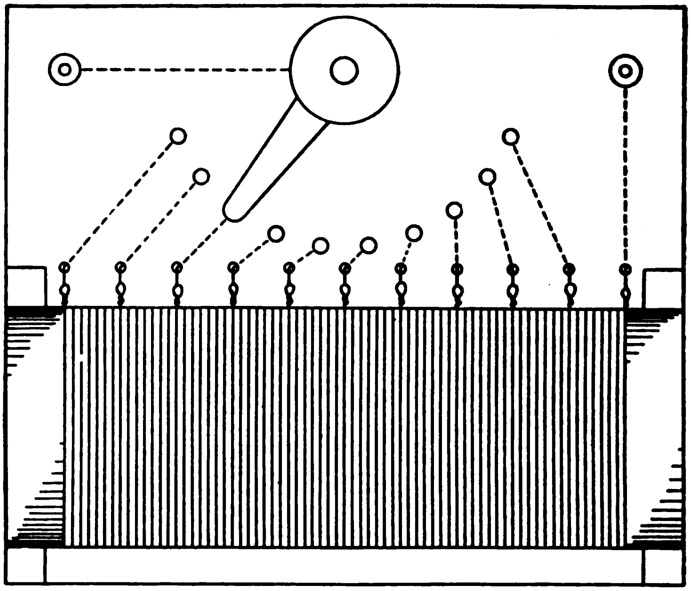


FIGURE 4
A plan view of the coil, showing how the switch joints, switch blade and binding posts are wired beneath the base-board.

ter, a ten point multiple switch; binding posts; some cotton or silk insulated No. 20 or 22 copper wire and a base or panel of wood or bakelite on which to mount the coil.

If the coil tube is one foot in length it will take practically 250 turns of wire, leaving half an inch bare at each end for attaching or mounting the coil.

Begin by making a small hole half an inch from one end of the coil. Run an end of the wire through this hole with six or seven inches projecting and fasten it to the inside of the tube by means of sealing wax. Then wind on the wire smoothly and evenly, keeping the turns close together until you have wound on twenty-five turns. Make a loop or tap in the wire (see Figure 1) and continue winding for another twenty-five turns. Here another tap should be taken and the winding should proceed, taking a tap at each twenty-five turns until the wire has covered the coil to within half an inch of the other end, when it should be passed through a small hole as in starting and secured in the same manner. This will give you nine taps and the loose ends.

The next step is to scrape carefully

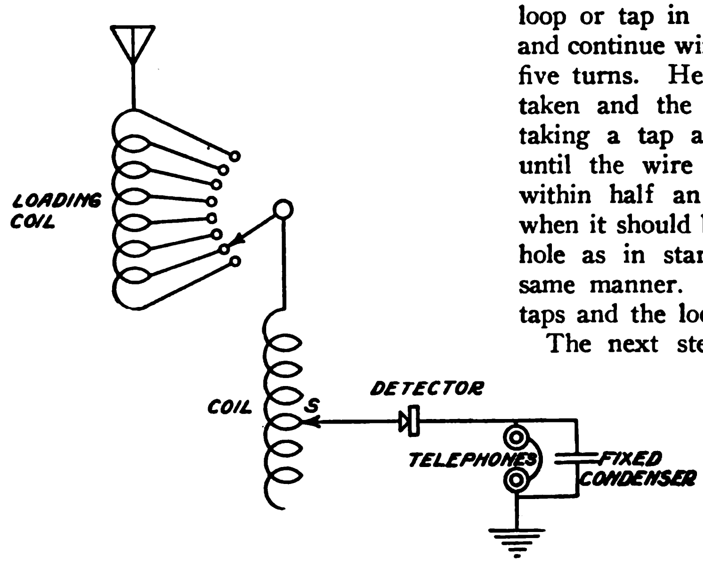


FIGURE 5
How the loading coil is connected in a single circuit receiver.

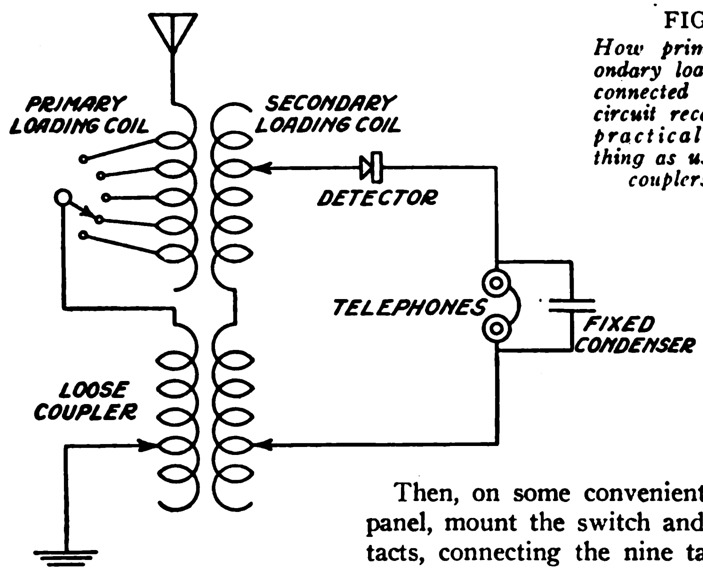


FIGURE 6
How primary and secondary loading coils are connected in a double circuit receiver. This is practically the same thing as using two loose couplers in series.

the insulation from the tap loops, clean the exposed wire and twist in a six or eight-inch length of wire in each loop. By twisting the wire around one side of the loop and then twisting the whole together (see Figure 2), a good connection may be made, but as soon as all have been thus twisted in you should go over them and solder the wires. Then slip a section of varnished cambric tubing over each tap and wire so as to completely cover the exposed copper.

The coil should then be mounted on a base or panel by using two uprights or supports, each with a half circular opening cut in them, as shown in Figure 3. The bare ends of the coil should rest in these and should be secured by means of small brass screws through the coil from the inside. Place these screws as close to the ends of the coil as possible and use as few and as small screws as will secure the coil firmly.

Then, on some convenient part of the panel, mount the switch and switch contacts, connecting the nine tap wires and one end wire of the coil to the ten contact points. Then connect the switch arm post to a binding post and lead the other end wire of the coil to a second binding post as shown in Figure 4. The coil is then ready to use; this is done by running your lead-in to one binding post and connecting the aerial terminal of your set to the other binding post as shown in Figure 5.

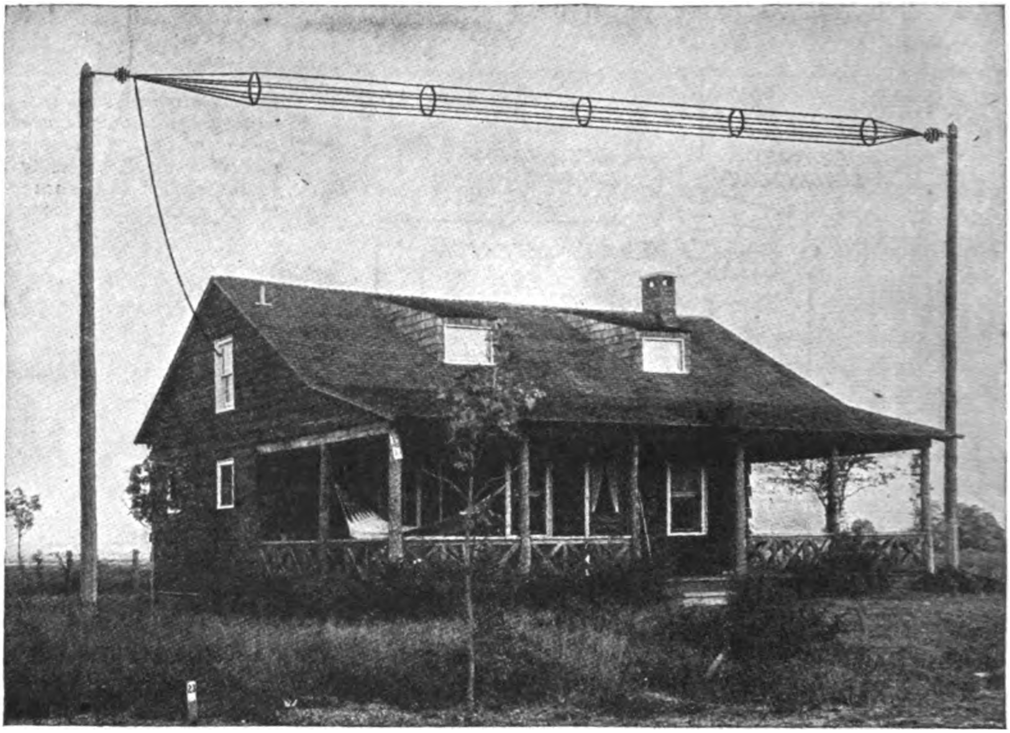
In tuning for the longest waves place the switch "S" at the loading coil end. Then move the loading coil switch to the proper point and do your finer tuning with the regular coil.

If your set uses a coupled coil the loading coil is a trifle more difficult to make, for it must consist of two inductances, one a trifle smaller than the other and placed within the other, each tapped and arranged to connect in series with the corresponding inductances on your set. (See Figure 6.) The same methods are followed in making these inductances.

To the Editor of Popular Radio:

"I should think that a project such as yours for improving the quality of the radio programs ought to have the heartiest support. . . . It would certainly be worth while for the college to install a complete receiving and amplifying set in one or more of the college auditoriums, if such programs as are suggested could be received."

George H. Nettleton
Acting President of Vassar College



From a diagram made for POPULAR RADIO

AMATEURS HAVE SENT AND RECEIVED TRANSATLANTIC MESSAGES WITH THIS TYPE OF ANTENNA

As the amateur is limited to transmission or low wavelengths a highly efficient antenna is a prime necessity. This is the best for his purpose.

The Best Antenna for Transmitting

THE CAGE TYPE

The Third of a Series of Short Articles on the Antennae Best Adapted for the Amateur's Uses

By DAVID LAY

THE cage type of antenna is meeting with increasing popularity among the advanced amateurs, especially with those amateurs who are trying to establish new records for transmitting. In view of the fact that the amateur is limited to small power for transmitting purposes, any increased efficiency that can possibly be obtained in the apparatus that he uses is of the utmost importance.

The ordinary flat-topped antenna uses four wires, the outside wires carrying more current than the inner wires; or in other words, the outside wires are worked at a higher efficiency than the inner wires. That this is so is shown by the comparison of electrostatic fields around the different wires of such an antenna. A cross-sectional view of these fields is shown in Figure 1. It will be noticed that the two outside wires 1 and 4 have more lines of force connecting them to the ground than the two inner wires 2 and 3. This of course indicates that there is more current flowing in the outer wires than in the inner ones, and this difference in current can be determined by actual test.

In the cage type of antenna the wires

are not spaced in a plane or flat top but are arranged in a circle, as shown in the diagram in the photograph. In an antenna of this design the currents flowing in the antenna wires are more evenly distributed; even the top wire has the same current as the lower ones.

In Figure 2 is shown a diagram of the electrostatic field that surrounds a cross-section of a cage type of antenna. Notice that all the wires have approximately the same number of lines of force attached to them. In this type of antenna all the wires are worked at the same efficiency.

This type of antenna also gets its increased efficiency because of its tubular shape, for it is well known that the metallic tube is the most efficient conductor of high frequency currents.

In building such an antenna it is advisable to cut the wires the correct length and lay them on the ground. If a six-

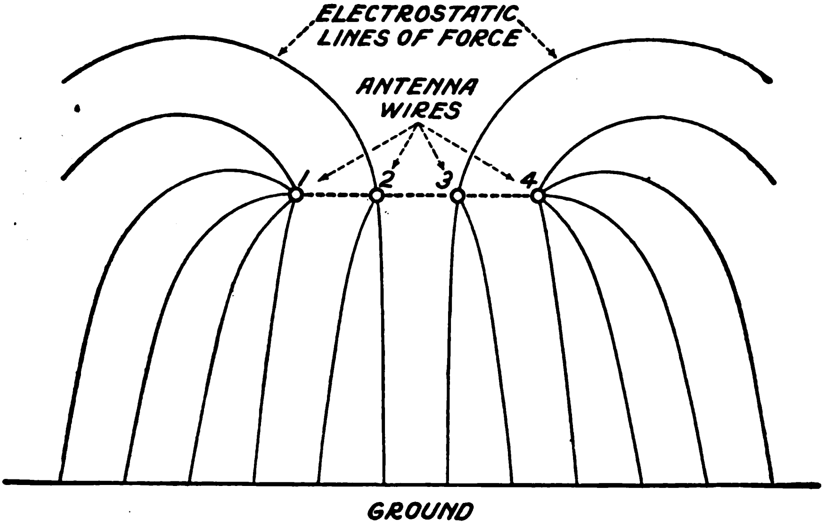


FIGURE 1

The potential gradient around the end wires 1 and 4 in a flat-top antenna is much greater than the middle wires 2 and 3. This is evidenced by the crowding of the electrostatic lines of force around the outer wires. In other words, the two outside wires do most of the work and the top side of the antenna does hardly any work at all.

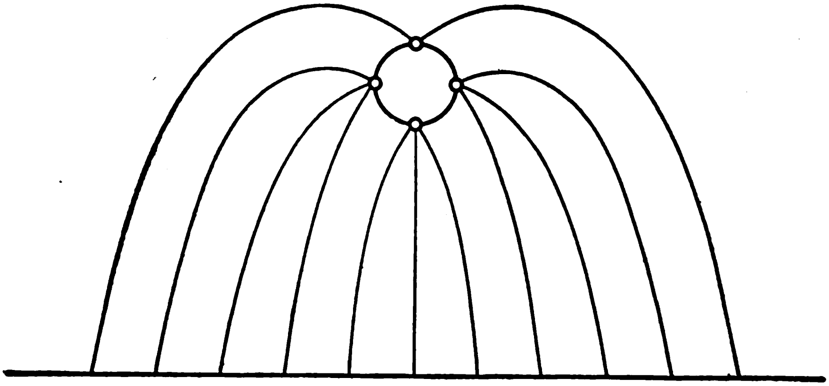


FIGURE 2

In the cage type of antenna, however, all the wires have practically an even chance, and each of them presents a much greater effective radiating surface than in the arrangement shown in the upper diagram.

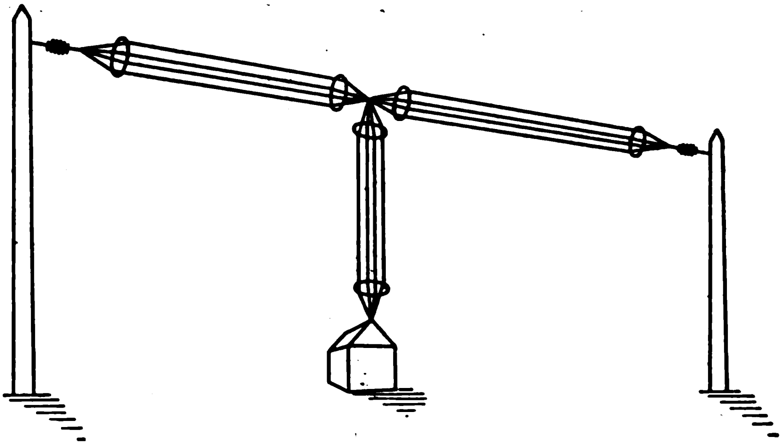


FIGURE 3

The cage antenna may be used as a T-type by building three small cages, using two of them as the horizontal part, with the third cage fastened between them and serving as the lead-in.

wire cage is to be built, six lengths are cut and stretched out along a flat piece of ground and one by one they are fastened and soldered to the supporting loops. These loops can be made of No. 00 hard copper wire bent into a circle one foot in diameter and soldered. There should be a loop at every 15-foot distance along the antenna. Thus for a 75-foot antenna, six loops will be required, including the additional loop at the end. Each loop should be marked with a file into six sections so that the wires can be attached and soldered in such a way that the position of each wire will be exact when the cage is hoisted into place

At the ends of the cage the six wires should be joined together and fastened to a long 22-inch insulator, to the other end of which is attached the supporting cable.

The cage antenna can be used as an inverted L type of antenna (see diagram on photograph), or as a T-type antenna. In the case of the inverted L-type, the lead-in is connected to the end of the cage; in the case of the T-type two smaller cages are used with the lead-in fastened between them as shown in Figure 3.

The lead-in may also be constructed in the form of a cage. The loops for the lead-in should be 8 inches in diameter, instead of one foot.

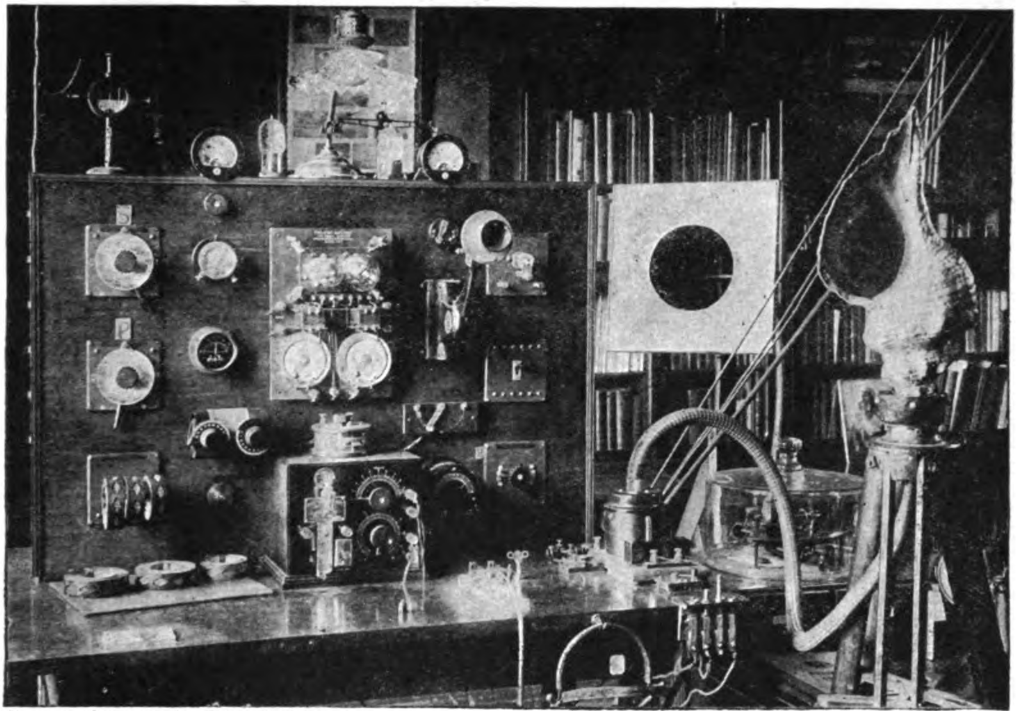
The Public Benefit of Good Broadcasting

To the Editor of Popular Radio:

"I heartily approve of your proposed plan to broadcast good music and valuable information from the great centers of New York and the country. I see no reason why this should not be done, especially as the expense of doing it is now relatively small and the public able to benefit by it is large."

Edward R. Hewitt

Treasurer, Cooper Union



From a photograph by Ewing Galloway

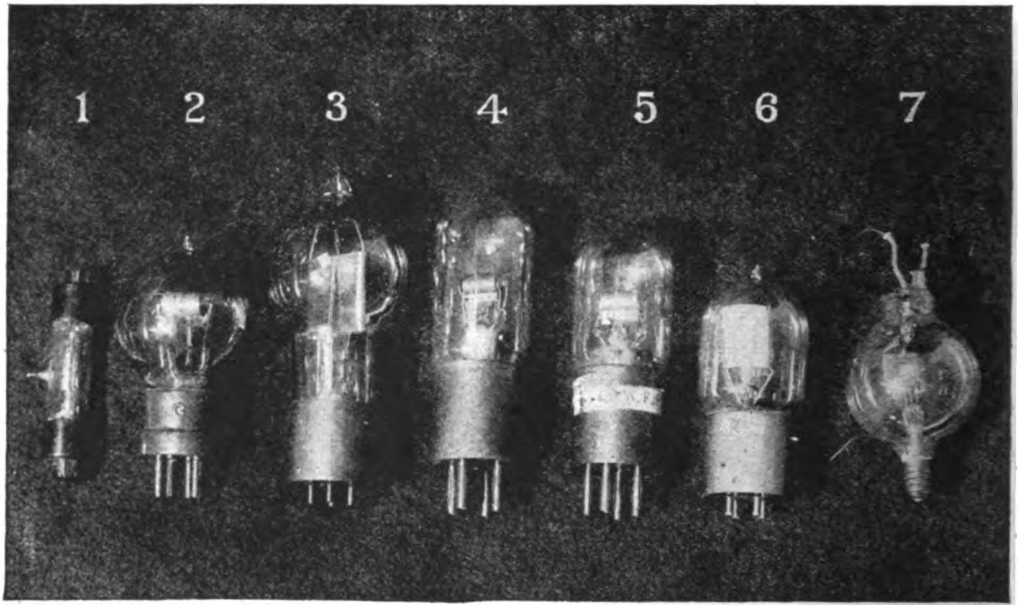
A "Loud Speaker" *from* a Conch Shell

A LOUD speaker made from a sea shell is a new and easily constructed device that amplifies the smallest details of broadcast music with a minimum of the echoes and harsh distortions made by metal amplifying horns.

The compartment of the human ear known as "the winding staircase" suggested the sea shell to the inventor, Father Frederick L. Odenbach. After experimenting he found that a triton or conch shell served the purpose best. So he sawed off the tip of the shell making a cross section of about an inch and a half in diameter. The opening in the sawed end of the shell was then widened out and the winding chamber inside was enlarged so that it was about the size of a finger. The shell was mounted on a block of wood to hold it solid, and a piece of ordinary garden hose was attached. The hose was extended to a sensitive telephone receiver or to one of the many commercial sound-amplifying devices which use a horn for a resonator.

The sea shell amplifier is reported to work well in a parlor, but for concert halls the inventor has perfected a pyramid horn of thin wood. The wooden horn is not quite as clear as the shell amplifier but it is more powerful. The pyramid horn was made two inches square at the small end and a foot square at the large end. Thin shellacked wood was used for all four sides, two opposite sides of pine and two of maple. The opposite sides were connected by thin splinters of wood, fitted into the interior of the horn.

Over the large end was placed a thin piece of wood with a round hole in the center, six inches in diameter. This was the ordinary wood used on the backs of framed pictures. The wooden pyramid was connected to some kind of electromagnetic amplifier, in the same manner as the sea shell was connected, with a length of rubber hose.



From a photograph made for POPULAR RADIO

AN UNUSUAL COLLECTION OF AMERICAN AND FOREIGN TUBES—*The various forms of vacuum tubes shown above may be identified as follows: 1, the Myers audion (American); 2, amplifier tube used by the French; 3, the De Forest rectifier tube (American); 4 and 5, German tubes made during the war (on account of the scarcity of brass in that country at the time, the bases of these tubes were made of iron); 6, the well-known Moorhead Electron-relay (American); 7, the original De Forest "Audion" (American).*

How *the* Vacuum Tube Detects

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 7

By LAURENCE M. COCKADAY, R.E.

IN the preceding article on the crystal detector we learned that radio frequency currents must be "rectified" or reduced to a pulsating direct current before they can be used to produce sound waves in the telephones. The crystal detector does this on account of its inherent "unidirectional conductivity." By unidirectional conductivity is meant the ability of the crystal to pass currents through itself in one direction, while preventing currents from flowing through itself from the opposite direction.

Thus, if a crystal be connected in an alternating current circuit, only half the impulses will flow through it and the other half of the impulses (trying to flow in the other direction) will be resisted, or held back. A crystal, then, conducts currents much better in one direction than in the other, and the current that actuates the telephones in a crystal set is that current (which happens to be flowing in the right direction) which the crystal lets through. It will readily be seen that this actuating current is but a part of the received energy, and if all the incoming current could be put to work in some way or other, much louder signals would be produced in the telephones.

We shall now see how the vacuum tube uses all of these received impulses, both positive and negative, and uses them so as to act as a trigger acts in a gun. It

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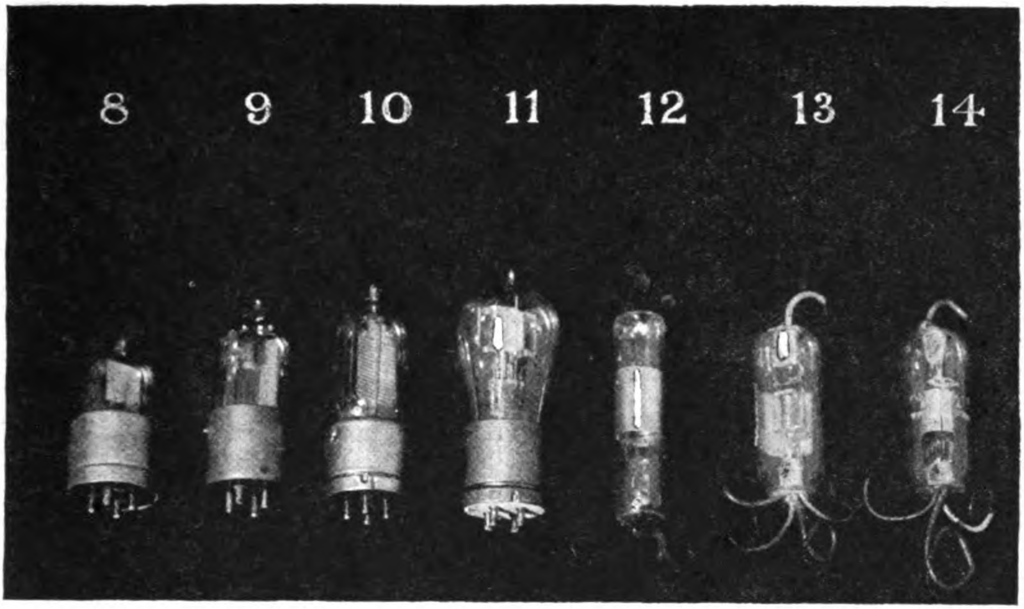
*See "How the Crystal Detector Detects," in POPULAR RADIO for October, 1922.



—INCLUDING SOME OF THE EARLY MODELS USED BY AMATEURS

8 is the De Forest VT-21, a wartime tube (American); 9, the Moorhead amplifier tube (American); 10, the Western Electric VT-1, used by the U. S. Navy and the U. S. Signal Corps during the war (American); 11, the Radiotron, now in common use for detection and amplification (American); 12, the tubular "Audiotron," at one time the amateur's favorite detector (American); 13, an amplifier tube with a second spiral grid that serves as a plate (Japanese); 14, a detector tube, evidently copied after the "Audiotron" (Japanese).

takes but a small effort to pull the trigger, although the resultant explosion is many times more powerful than the trigger effort. So the vacuum tube uses the feeble received currents to "trigger off" larger currents supplied by the "B" battery and in this way at the same time amplifying or strengthening the signals. In this case the "B" battery may be likened to the powder in the gun, and the feeble incoming impulses may be likened to the pressure upon the trigger. An incoming impulse pulls the trigger of the vacuum tube, so to speak, and the "B" battery connected in the plate circuit of the tube immediately "shoots" the energy to reproduce the trigger impulse in much amplified fashion. This is made possible by the rectifying and amplifying qualities of the vacuum tube itself, giving receiving results far superior to those of the crystal detector which possesses only the quality of rectifying.

Edison, while studying the effects of heated filaments of carbon in the old-fashioned electric incandescent lamp, found out that the filament got thinner and thinner as the lamp burned, and that the glass bulb began to get darker and darker at the same time. The filament seemed to be disintegrating, and giving off particles which shot across the evacuated space and stuck to the glass. He conceived the idea of placing another electrode or wire in the lamp that would collect these little particles which constantly were being driven away from the filament. Later he found that the extra wire became charged slightly negative every time the lamp was turned on, and finally a battery was connected across between the wire and the filament, with the positive terminal of the battery connected to the wire. Immediately a current was detected flowing in this circuit, and when the lamp was turned off, the current promptly stopped. This action was called the "Edison effect," and we know

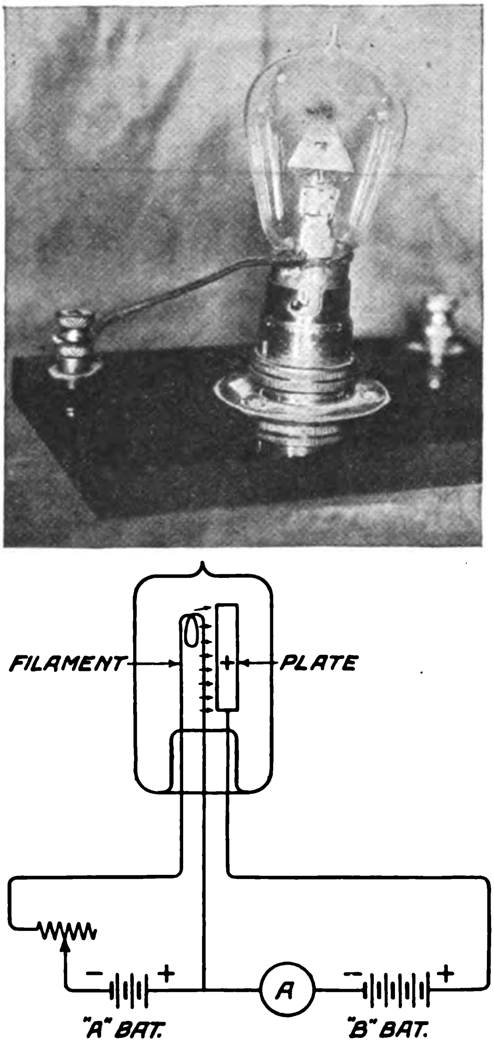


FIGURE 1

A model of the first vacuum tube, made by J. A. Fleming in England; it contains only the filament and the plate. The diagram illustrates its unilateral conductivity.

now that all filaments when heated in a vacuum give off electrons which fly off and away from the filament.

Fleming made use of the Edison effect when he designed his valve which consisted of a filament and a metal plate in a vacuum tube. In Figure 1 is shown a diagram of a Fleming valve connected to an "A" battery for heating the filament and a "B" battery for keeping the plate positive to help attract the negative electrons. When the tube is connected up (as shown in the diagram) with a current-measuring device, A, connected in series with the "B" battery, and the "A" battery current is turned on (thus heating the filament), a current is immediately indicated by A, flowing in the plate circuit. If the "B" battery is reversed so that the plate is negative, no current is measured by A, showing that the tube will pass current from the plate to the filament, but not from the filament to the plate. This of course is true only while the filament is heated and giving off electrons—the electrons really constituting the plate current, although we consider the current as flowing in the opposite direction to the electrons.

Before we go any further, there are three points to remember which are important if we are to understand the action taking place in the vacuum tube:

First: a vacuum tube will pass current only from the plate to the filament.

Second: the strength of this current is dependent upon the density of the stream of electrons passing from the filament to the plate.

Third: the density of the stream of electrons is dependent upon the temperature of the filament, the kind of material the filament is made of, the distance between the filament and the plate, and the amount of "B" battery potential applied to the plate.

While experimenting with electron streams in flames and hot gases, De Forest found that he could control the strength or density of the stream of electrons by placing a charged wire mesh in the path of the stream. That this is a fact will at once be evident to anyone who knows that "like charges repel, and unlike charges attract." The electrons are negative, and when the mesh is charged negatively the electrons in the stream which are trying to pass through the holes in the mesh are repelled and the stream is reduced and stops, and when the mesh is charged positively, the electrons are strongly attracted and the stream is increased and strengthened.

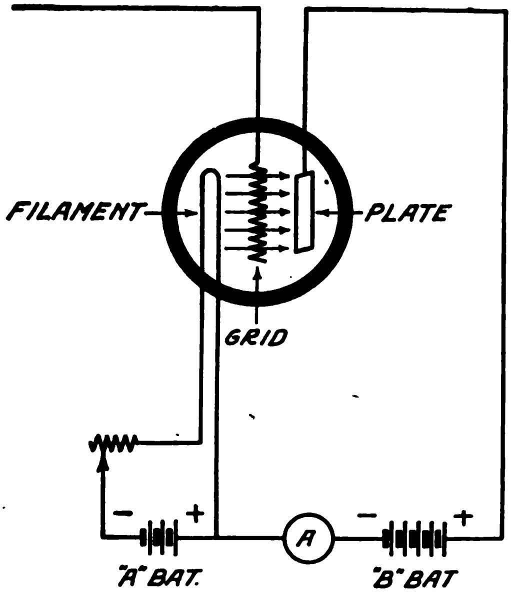


FIGURE 2
Diagram of the insulated grid in the vacuum tube.

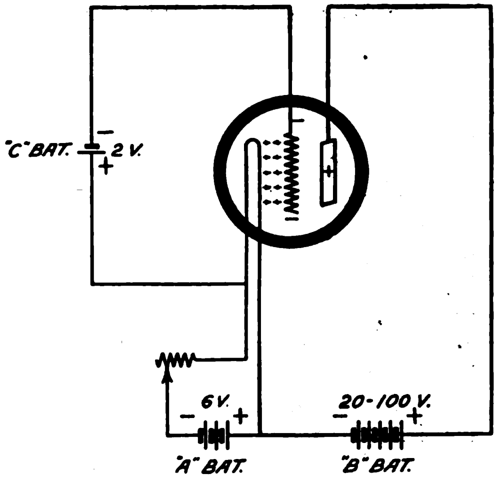


FIGURE 3
This diagram illustrates the action of the negative charge on the grid.

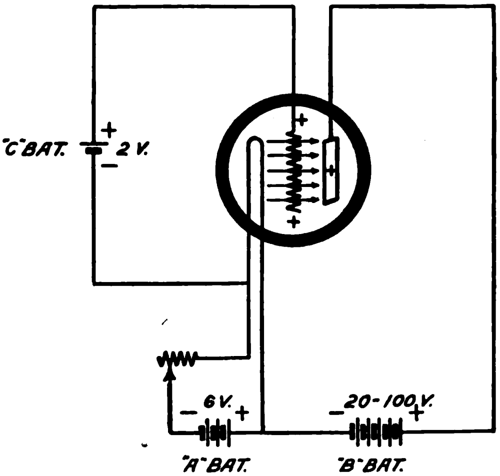


FIGURE 4
The action of the positive charge on the grid. Compare this with the diagrams above.

De Forest then applied this principle to the vacuum valve and interposed his famous "grid" in between the filament and the plate. (See Figure 2.) In this diagram the grid is shown disconnected and has no externally applied charge on it. In this state the tube would act about the same as the Fleming valve; that is, there would be a flow of electrons across from the filament to the plate if the filament is heated. This is the same as stating that a current would flow from the plate to the filament (refer to the three points to be remembered, mentioned above). The electrons would pass through the spaces in the grid.

Now suppose we should connect a small battery "C" across from the filament to the grid with the negative terminal connected to the grid and the positive terminal connected to the filament, as shown in Figure 3. This would make the grid negative with respect to the filament, or in other words a negative charge of 2 volts will be placed on the grid. Let us study the effect of this charge on the grid in the diagram. The electrons trying to leave the filament, represented by the arrows, are negative. The grid is charged negatively, by the "C" battery. Remembering the fact that "like charges repel and unlike charges attract," we readily see that the electrons are repelled and forced back to the filament; a small number, or none, ever get across to the plate. Hence, in this condition the tube lets little or no current across from the plate to the filament.

What would happen if we suddenly were to reverse the terminals of the "C" battery which is charging the grid? Let us investigate in Figure 4. In this case the grid would have a positive charge of 2 volts, and the negative electrons would be strongly attracted across from the filament to the grid. When they get this far on their journey they begin to feel the greater attraction of the higher positive voltage charge on the plate and they pass through the spaces in the grid in a flying effort to get to the plate, which receives them "with open arms," so to speak. The attraction of the positive charge on the grid draws many times more electrons from the filament than would ordinarily leave it, and thus the density of the stream is increased many times. Another reference to our famous three points will prove that there is at this time a much stronger current flowing from the plate to the filament. The current flowing across from the plate to the filament of course is a direct current, and is known as the "plate current" of the tube. To sum up the action of the tube in a few words, we might say that "the plate current (explosion) of the vacuum tube can be controlled by the voltages (trigger) applied to the grid."

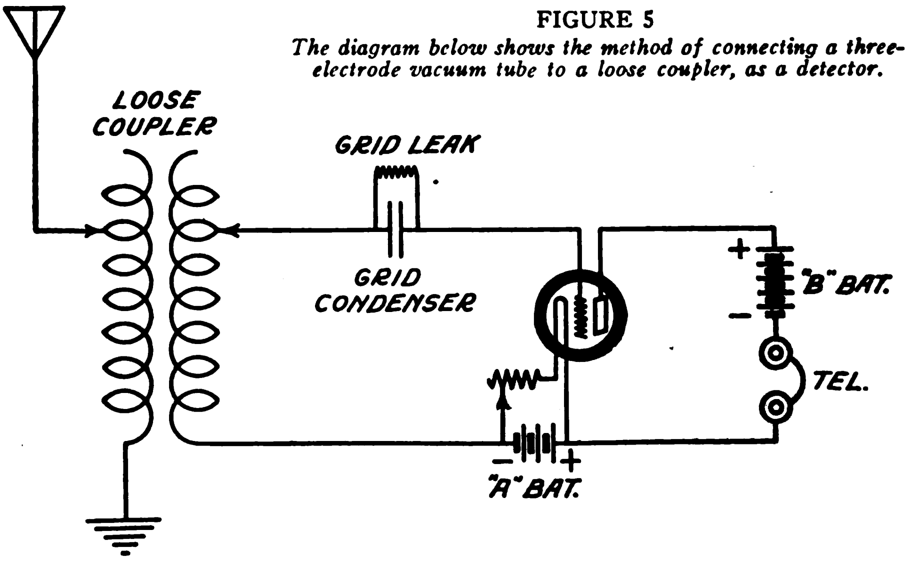
Now we can see the likeness between the action of the vacuum tube and the action taking place in firing a gun.

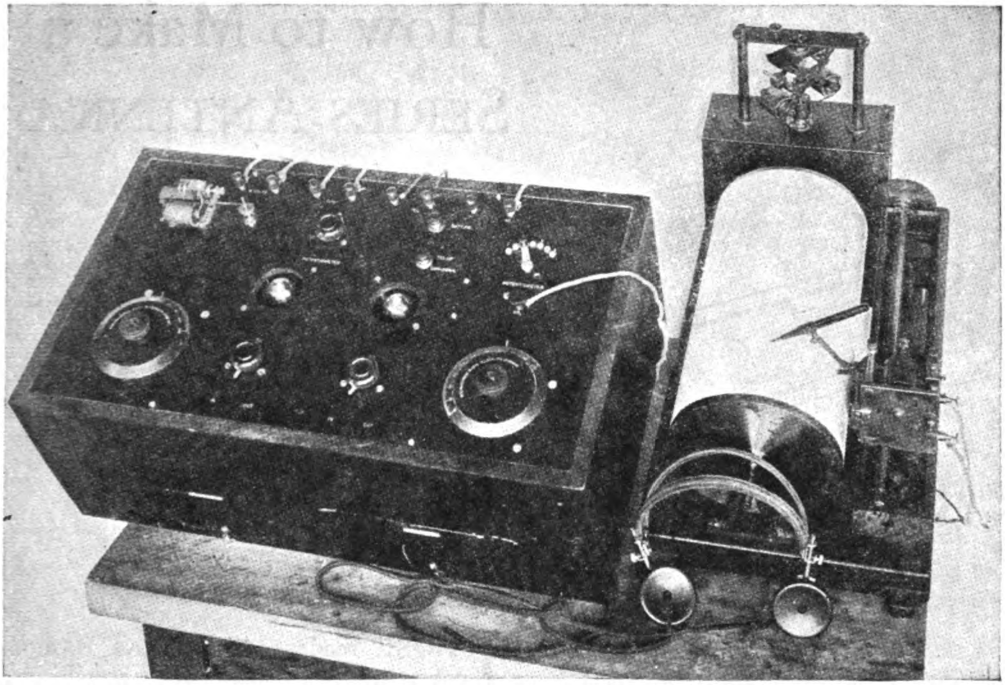
It takes a very small change in grid voltage to effect large changes in the values of plate current, and it is this plate current that is used to actuate the telephones in a vacuum tube receiving circuit. The feeble received impulses are used to "trigger off" much larger currents supplied by the "B" battery, in this way at the same time amplifying and strengthening the incoming signals. This is the reason why the vacuum tube gives so much stronger signals than the crystal detector, which only rectifies the weak incoming impulses.

In Figure 5 is shown a conventional circuit with a vacuum tube used as a detector. The loose coupler is used to tune in to the desired wavelength, so that the radiated energy may be received and applied to the grid in the form of high frequency impulses. These impulses vary the amount of the direct plate current of the tube so that the same voice waves as spoken into a distant telephone transmitter are reproduced and amplified in the telephones which are connected in series with the plate and "B" batteries. A grid condenser is used to supply the incoming charges to the grid of the tube. The grid leak resistance is used to prevent the negative charges accumulating on the grid in such large quantities that the tube becomes inoperable.

FIGURE 5

The diagram below shows the method of connecting a three-electrode vacuum tube to a loose coupler, as a detector.





Bureau of Standards

With the aid of an ordinary fountain pen, this novel radio set makes a written record of code signals that come in during the operator's absence.

A Receiving Set that Takes Down Notes

IF you are an operator, amateur or professional, who fears that some message of value may come in by radio while you are away from your receiving set, you need carry your anxiety no longer. You may merely employ a mechanical understudy that will automatically take down the signals—and take them down in writing—while you are absent.

This novel device has been built by Dr. E. A. Eckhardt and Dr. J. C. Karcher of the Bureau of Standards in Washington. It copies down the dots and dashes sent from a distant transmitting station without any supervision whatever from a radio operator, and the permanent record made by this machine may be deciphered at leisure by anybody who possesses a copy of the code chart. The dots and dashes are recorded as short and long humps along a continuous spiral inked line made by an ordinary fountain pen around a slowly revolving cylinder—shown on the right of the illustration.

A feature of the device is the fact that it functions without the use of amplifiers, yet at the same time it is possessed of great sensitivity, copying messages from as far away as Lyons, France—a distance of 3,800 miles.

The actuating mechanism for moving the pen back and forth and sidewise while the cylinder revolves (thus recording the received impulses), consists of an extremely sensitive electromagnet.

The device was built for the specific use of the Coast and Geodetic Survey of the United States Department of Commerce, and at present is being used for recording time signals on surveying expeditions in remote sections of the country.

It is conceivable that from this device may be developed a machine for long-distance writing by radio—even to the signing of checks.

How to Make a
SERIES-ANTENNA CONDENSER

Do you want to increase the flexibility of tuning in your set—especially on the lower wavelength ranges? This article tells how to make the necessary condenser for 50 cents.

BY WATSON DAVIS

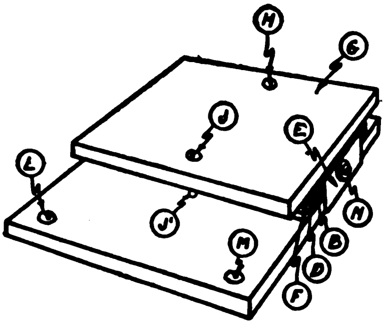


FIGURE 1A
This drawing shows the condenser completely assembled. The parts designated by letters are described in the accompanying text.

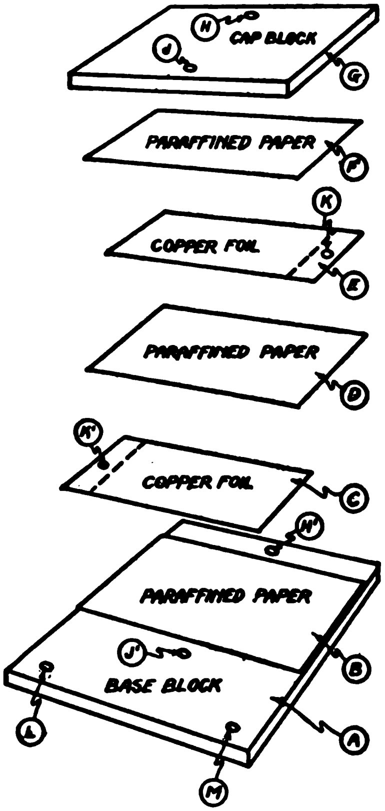


FIGURE 1B
This diagram shows the component parts of the condenser in the correct order of assembly reading from the bottom upward. The different parts are prepared as indicated in this article.

THOSE readers of POPULAR RADIO who have built the radio receiving sets that have been developed by the Bureau of Standards in Washington and described in specific detail in this magazine* may now improve their apparatus by adding a condenser in the antenna circuit. The fact that this addition may be made at home for the modest sum of about half a dollar commends it to the radio fan to whom the cost is a factor as well as to the fan who finds delight in building his equipment with his own hands.

The effect of the series-antenna condenser in a receiving set is to enable the receiving equipment to give signals of somewhat greater intensity when tuned to wavelengths of 300 meters or less. It will thus be seen that the effect of this condenser is just the opposite of the effect obtained by a greater number of turns of wire on a tuning coil, which, it will be remembered, permits the receiving equipment to respond to longer wavelengths.

The series-antenna condenser described here has a rated capacity of about 0.0003 microfarad (300 micromicrofarads). This is how to build it:

---

*See "How to Make and Install Your Own Receiving Set" in May, 1922; "How to Make and Operate a Two-Circuit Receiving Set" in July, 1922, and "How to Add a Vacuum Tube to Your Crystal Receiving Set" in November, 1922.

How to Make the Condenser

The condenser is shown in detail in Figures IA and IB. Two thin strips of metal, C and E, 1 inch wide and 3 inches long, are used with three sheets of insulating material, B, D and F, 1½ inches wide by 3 inches long. The metal strips may be thin copper, brass or aluminum. Each of the three sheets of insulating material is made up of two pieces of heavy white writing paper which are separately dipped in clean, melted paraffin. Each pair of sheets is then pressed together by means of a warm iron; when cold the strip is cut out to the required size. A sheet of clear mica, of about the same thickness as the two sheets of writing paper mentioned above may also be used for the insulating material. Two blocks, of hard wood (G is 2⅝ by 3½ inches, A is 3 by 3½ by ½ inches) are cut out. Two screws pass through holes H and J in the upper block G, which is placed over the block A, so that the edges of the two blocks are even on three sides. (See Figure 1A.) The holes for the screws H and J are ⅜ inch from the sides of the block G and equally distant from the ends.

Having located the correct position of the block G, the screws in holes H and J are loosened and the block is removed from A, leaving two small holes H^1 and J^1 to locate the proper position of the blocks when the condenser is finally assembled. The two screws L and M are located just far enough in from the front edge (see A Figures 1A and IB) so that the block A may be screwed to the left end of the baseboard of the receiving set. (See Figures 2 and 3).

The wooden blocks are of dry wood smoothed up with sandpaper and given a coat or two of varnish which will not absorb moisture, or treated with paraffin.

A sheet of the paraffined paper (or mica) B is placed on the block A between the holes H^1 and J^1 so that its ends are even with ends of the block. A thin metal strip, C, is placed in position so that it lies in the center of B and has its right end ½ inch in from the edge of the base block and its left end projecting ½ inch over the opposite edge of the base block. (See Figure 1B.)

Another sheet of paraffined paper D is placed on C directly above B. The second piece of thin metal E is placed on D and above C, except that one end of the metal strip E extends ½ inch over the *right* edge of block A instead of the left, as did C. The third sheet of paraffined paper F is placed on E directly above D and B.

The alternate sheets of paraffined paper and thin metal are held carefully in position, and the block G is placed over them and screwed in position. The right end of the thin metal strip E is bent down, and a round-head brass screw N is passed through a hole K punched or drilled in the end of the metal strip. The projecting end of the strip C is not visible in the Figure IA, but it is bent and fastened

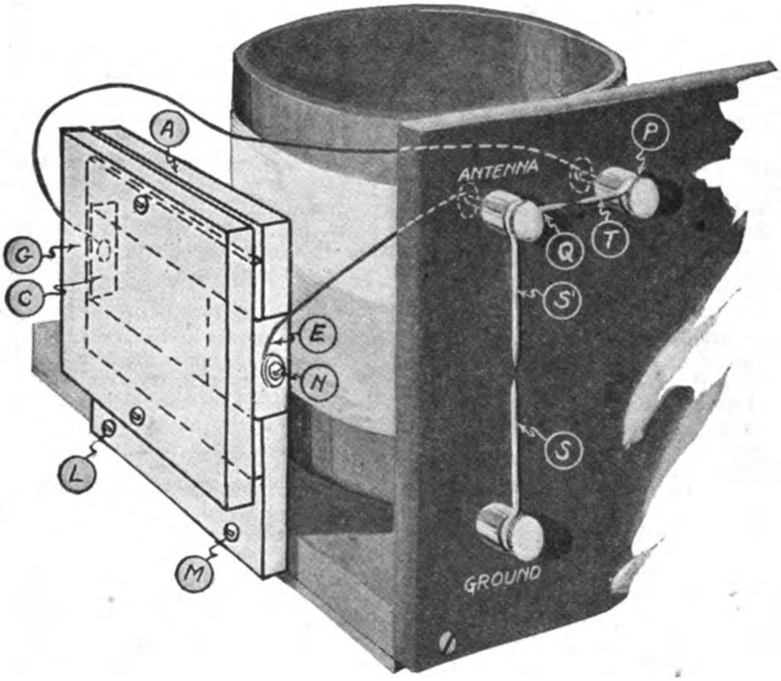


FIGURE 2

How the condenser is used in combination with the single circuit receiver.

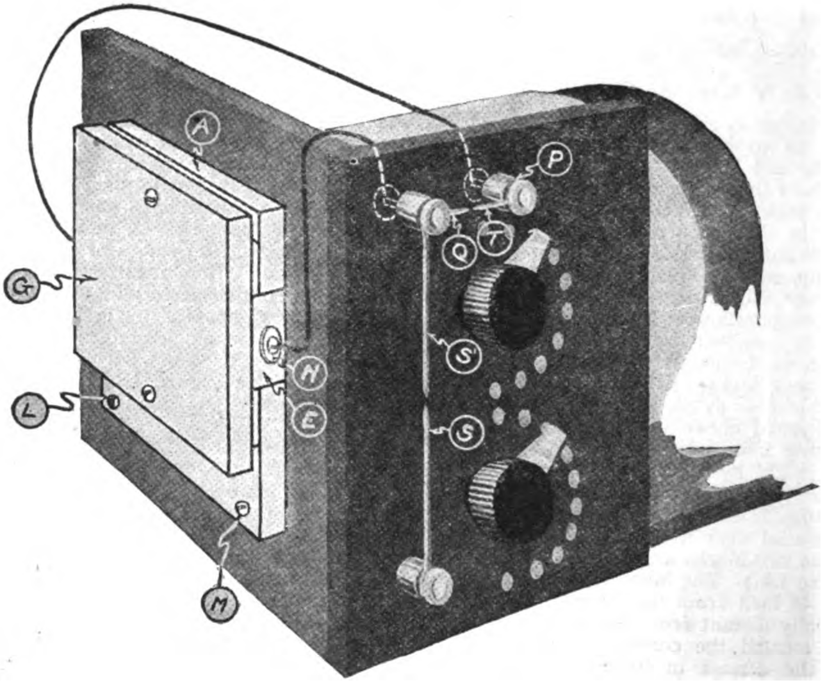


FIGURE 3
This drawing shows how the antenna condenser should be connected to the double circuit receiver.

in the same manner as E. The completed condenser resembles the sketch shown in Figure IA.

How to Mount and Wire the Condenser

The condenser is mounted on either the single-circuit receiving set described in the May issue of *Popular Radio* or the two-circuit receiving set described in the July issue. Figure 2 shows the method of mounting the condenser on the single-circuit receiving set. The condenser is fastened to the end of the baseboard by means of the screws L and M. A binding-post P is added to the panel of the receiving set about 1 inch from the binding-post marked "Antenna," as shown in Figure 2. A wire is clamped under the condenser screw N which passes through the metal strip E, forming one terminal of the condenser. This wire is led to and connected to the back of the binding-post marked "Antenna" without disturbing any of the other wires which are already connected to this binding-post. Another wire is connected to the terminal of the metal sheet C and led to the back of the binding-post P.

In the diagram in the May issue a short stiff wire is shown attached to the "Antenna" binding post and extending toward a similar wire attached to the "Ground" binding-post. The wire on the "Antenna" binding-post is removed and a longer one substituted so as to form parts Q and S; Figure 2. A similar short piece of stiff copper wire T is attached between the first and second nuts of binding-post P. There is a very short gap between wires Q and T and between S' and S. These gaps are for protective purposes when one forgets to throw the lightning switch to the grounded side. Another method of protection would be to install a lightning arrester in the antenna system. The arrester may be installed just outside or just inside of the building, preferably the former. This serves as an extra precaution when one forgets to throw the lightning switch to the ground terminal when the receiving set is not being used.

If the condenser is mounted on the receiving set described in the July issue, it may be placed as shown in Figure 3. In other words, it is mounted upon the vertical board which supports the primary coil tube previously described. The connections from the condenser to the binding post on the front panel of the two-circuit set are made as described above.

If the connections to the receiving set have been made as described, the antenna lead-in wire is removed from the binding-post marked "Antenna" and connected to the new binding-post which has been added to the front panel of the receiving set. (See P, Figures 2 and 3). The condenser is now included in the electrical circuit together with the tuning coil, between the antenna and ground. This connection to the binding-post is used when it is desired to receive wavelengths of 300 meters or below. To receive wavelengths of 300 meters or more, the antenna lead-in will ordinarily be connected to the binding-post marked "Antenna" and the operation of the receiving set is then as described in the previous articles. The switches are set so as to include more turns of wire on the tuning coil (or the primary coil of the two-circuit receiving set) with the antenna lead-in connected to F than when it is connected to the binding-post marked "Antenna," when tuning to a given wave frequency.

This will provide greater coupling, resulting in greater energy transfer from the primary to the secondary, and hence louder signals.

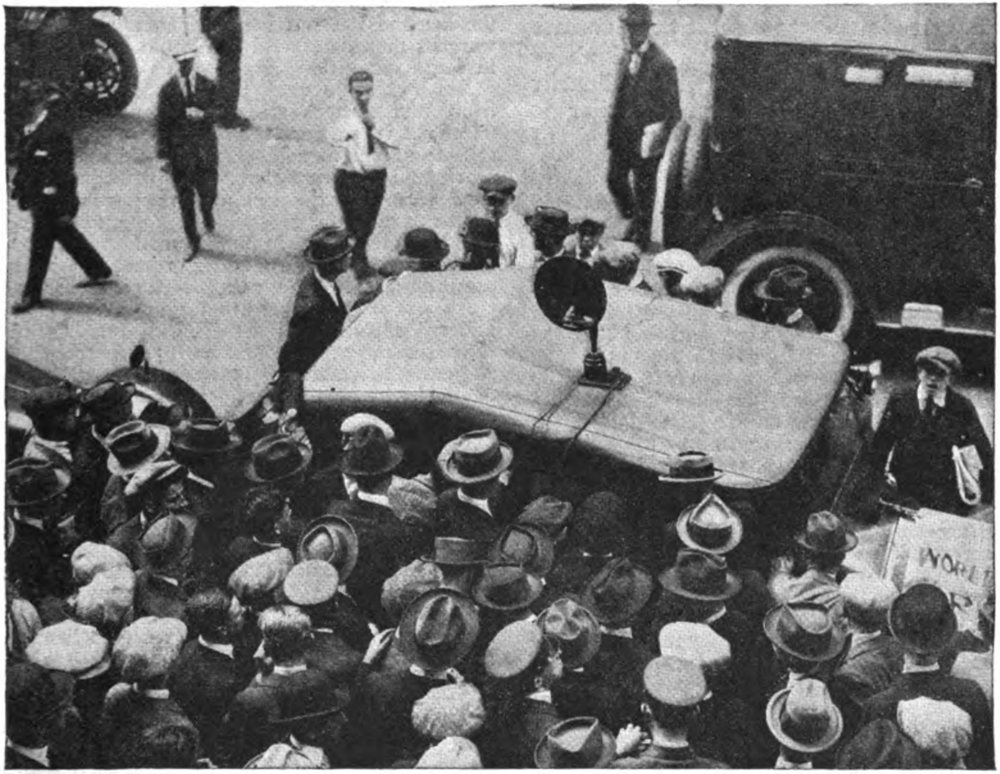
What It Will Cost

The material required and the costs of the various items are listed as follows:

2 metal strips (copper, brass or aluminum)	$0.10
3 sheets of mica (if used)	.20
1 binding-post (any type)	.10
6 wood-screws	.10
2 small wooden blocks	
Paraffin	
Paper	
Total cost	$0.50

Photographing Our Emotions—by Radio!

¶ How highly sensitive radio apparatus is now being used in the realms of medicine for recording the physical and nervous conditions of patients; how this same apparatus is even making graphic records of the reactions of our thoughts—will be told in the January issue of POPULAR RADIO by Dr. Henry Smith Williams.



International

RADIO BRINGS BASEBALL TO THE CURB

Some intimation of the possibilities of radio for adding to the sum of human happiness was demonstrated over a wide area during the World-Series baseball games in New York, when sideline reports of each play were broadcast from WJZ—thanks to the timely cooperation of the Western Union in furnishing wires. One enterprising radio amateur installed a receiver on his motor car and demoralized the financial center of the world for a few hours when he established himself on Wall Street and permitted millionaires and office boys to follow the score.

HELP your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.

How to Combine Your Crystal and Your Vacuum Tube

ONE reader finds that he can use a crystal and vacuum tube at the same time with a saving of life of both the tube and batteries and at the same time increase the strength of signals over and above the strength that a crystal will ordinarily produce. He uses a circuit similar to that on page 222 of the July issue of POPULAR RADIO. He writes:

> I have my crystal detector connected across my vacuum tube circuit; that is, from the top side of my loose coupler to the negative terminal of my "B" battery. This enables me to hear signals through my crystal detector. Then I turn on the tube, with the crystal still connected, and find that the signals increase in sound to a point nearly equal to that of the tube when it is used by itself with about half the current it takes to bring in the signals on the tube. I have the wire connecting the crystal to the negative "B" battery loosely connected and by lifting it away and thus disconnecting the crystal, the signals disappear. This proves that by the use of both detectors the signals can be increased with half the power from the battery, which saves the charge in the battery and at the same time lengthens the life of the tube, as it does not have to burn so brightly. Test this out to your own satisfaction and see what you think about it.
>
> W. J. THOMPSON

* * *

The High Cost of Radio in Germany

THE radio fan abroad is not blessed with the advantages of his Yankee *confrère*. The handicaps under which Hans struggles in Germany, for instance, is briefly outlined by Vice-Consul Nathaniel B. Davis in Berlin:

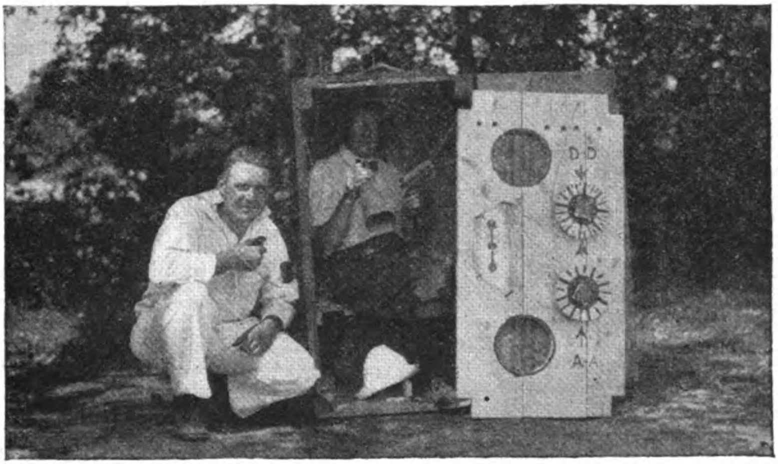
> German manufacturers of radio apparatus and equipment are not in a position to make extensive deliveries of their product. This is due to the fact that up to the present time the demand has not been sufficiently great to warrant the manufacture of radio instruments in large quantities.
>
> Amateur radio work is not popular in Germany and stations are not numerous. Radio telephony in particular is almost an unknown science except to engineers, professional operators, and experimenters. The principal reasons given for the lack of interest in radio on the part of the general public are that amateur stations are a luxury beyond the means of the average German, under present economic conditions, and official restrictions on their use.
>
> All radio communication in Germany is under the control of the Federal Post Office Department, which operates the commercial stations. Private installations must ordinarily be made by the Department; in exceptional cases private companies or individuals may be authorized to erect their own plants, but they must first obtain a license from the Post Office Department. The fee for such a license varies according to the size of the plant, with a maximum of 2,000 marks a year.
>
> At present only one station in Berlin is licensed to broadcast. This station broadcasts market and exchange quotations. Subscribers to its service are permitted to install receiving stations upon payment of the license fee and the monthly subscription rates, which vary at present from 1,000 marks to 7,500 marks, according to the class of subscription. Subscribers may rent receiving sets from the Post Office Department for 2,500 marks a month if they do not desire to build their own.
>
> In spite of the lack of demand for shortwave amateur apparatus there are a number of firms in and about Berlin which manufacture either complete receiving sets or parts. Vacuum tubes are almost unavailable, and practically all receiving sets manufactured in the Berlin district operate with crystal detectors.

Blocking Bandits with Radio

THE use of radio for running down law-breakers is not new. But a novel and dramatic use of it is being found, for it is thwarting the bandits of Mexico; here is a description from a former official of the American Chamber of Commerce in Tampico:

> It took robbery and violent death at last to bring radio into the Tampico oil fields as the new hope of the oil companies, and the *rurales* who are supposed to preserve law and order. The recent killing of one American, the wounding of two others and the taking of 42,000 pesos from a paymaster for the Companias del Agwi finally decided that organization to apply to the Mexican Government for a permit to install radio receiving and sending apparatus, for connecting its headquarters in Tampico with its sea loading stations and camps in the lower field, in the State of Vera Cruz.
>
> Robberies have been of almost weekly occurrence in the great Tampico field, which takes in hundreds of square miles of jungle in which, heretofore, the bandits have found it easy to outwit the *rurales*. A gang of bandits that was recently broken up was armed with portable telephones and had been listening in on the private lines of companies; there is little doubt that the arrangements for the transportation of the payroll stolen from the Agwi company were discovered by the bandits in that manner. The company had arranged to send the money over the most dangerous part of the trip by airplane, believing it could evade bandits in that way, but the bandits evidently had learned all the details of the plan, and held up the paymaster before he reached the place where he was to have taken the airplane.
>
> The Mexican Government has a monopoly on all telegraph and telephone communications, however, and it is only by special permit that any private company can transmit or receive messages. The great oil companies have such permits and all the principal companies have private telephone lines—the only long-distance telephone lines in Mexico. All radio outfits which cross the border, therefore, must be reported to the Mexican Government, and it is believed that the government can easily keep tab on all such equipment in territory under its control, so that it will be virtually impossible for bandits to listen in on the oil companies by radio. At present, the bandits know nothing of radio.
>
> The experiment the Companias del Agwi is about to make will be watched with great interest by about thirty other oil companies, and it is probable that soon radio will have secured a start in Mexico from which there will spread rapidly, enlightenment and progress throughout the entire Republic.

LEE SHIPPEY



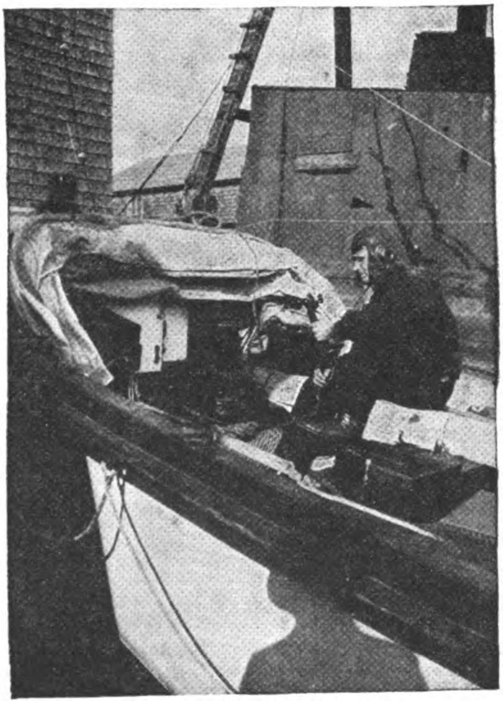
A STATIC-PROOF RADIO SET

When two hundred members of the American Canoe Association recently gathered at Sugar Island, near Ganagoque, Canada, for an evening's entertainment, they were treated to a truly remarkable exhibition of the possibilities of radio. A huge (and obviously home-made) receiving set was carried out before the audience, an aerial was solemnly run up on a flag-pole and a serious radio lecture was delivered by the "operator," Oscar S. Tyson. Inside of the set was concealed George P. Douglas, who with the help of a phonograph for music, a megaphone for speaking, two flashlights for tubes and several "rattlers" and "squeakers" for static gave a very creditable bit of broadcasting which entirely fooled the audience—until the front plate of the set was removed at the end of the entertainment.

Radio on Life-Boats

EVEN the life-saving boats of the romantic Coast Guard service are becoming modernized—by the installation of radio sending and receiving apparatus. (Glance at the cover design on this magazine.) Some months ago the Bureau of Standards conducted some tests of this equipment off Atlantic City; new experiments are now being carried on at the Curtis Bay Station, south of Baltimore. Only the expense of the apparatus has prevented earlier installations. How the problem is being worked out is told by an expert as follows:

The one great hindrance to the work of life-saving corps has been in maintaining communication. In pre-radio days the only methods of communication between a foundering ship and vessels were the use of rockets and the shooting off of bombs, and even these were of limited value as they served only as a means for determining the approximate position of the vessel in distress, and could give no details of the trouble.



THE MODERN SUCCESSOR TO THE ROCKET

Conversation by radio between shipwrecked mariners and their rescuers may lack the dramatic touch furnished by fireworks-signals. But it will save more lives.

Radio, as supplied to the vessels themselves, has offered a partial solution to this problem; the application of radio to the life-boat itself has been a more difficult problem to solve, largely because an antenna mast and antenna on a life-boat, even though of the sturdiest construction, could last only a few moments in a heavy sea. Further, when a life-boat approaches a ship's side, the aerials would undoubtedly be carried away when the boat rolled over against the vessel. To overcome this difficulty a new type of antenna has been developed which does not require masts; it is virtually a loop antenna, and is the outcome of a considerable amount of experimental work in connection with the installation of radio on submarines.

A heavily insulated wire is run from the bow of the life-boat down along one side of the keel, extending back to the stern, up the stern, and then back to the bow on the same side of the boat along the scuppers. The same wire is then led in the same path, fore and aft, on the other side of the boat, so that it forms a two-turn loop. The two terminals are led to the radio telephone installation which is located under the canvas spray-hood. This form of antenna can be used for both transmitting and reception over the normal cruising range encountered. The equipment used is of the Western Electric type that was employed during the war on submarines and sub-chasers. The transmitting and receiving apparatus used at the Coast Guard land station is also of the Western Electric type.

By the use of this new equipment, the life-saving boat may be at all times in two-way communication, not only with the land base, but with the vessel in danger, and with other ships standing by.

D. C. SANDERS

Side-line Reports by Radio

ONLY the inability of the broadcasting stations to obtain the necessary telephone wires for transmitting side-line reports of the big football games this fall prevented the radio fans from listening in on any considerable number of these picturesque events. One university is apparently going to do its own broadcasting in its own way, as this note from New Haven will attest:

The authorities at Yale University announce that in the future athletic events will be broadcast by radio to the surrounding cities. This means that anyone within a distance of about fifty miles of New Haven will be able to receive by radio play-by-play reports of the football, hockey, lacrosse and other games.

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: Please give me a hook-up for a tuning coil, a crystal detector, a variable condenser and a honeycomb coil.

T. P. D.

ANSWER: A circuit that uses the instruments you have on hand is illustrated in Figure 1. You will not need the honeycomb coil, but you will get better results if you obtain a fixed telephone condenser and hook it across the telephones as shown in the diagram. This condenser will serve to shunt the radio frequency currents *around* the telephone, allowing only the audio frequency currents to pass *through* them.

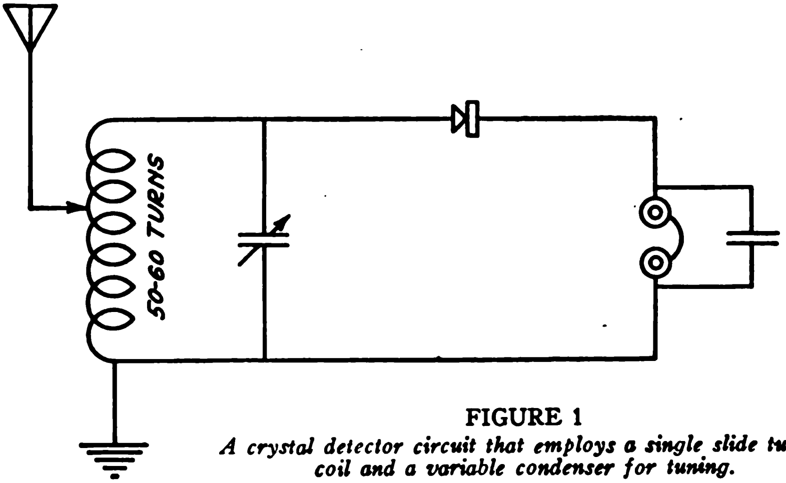


FIGURE 1

A crystal detector circuit that employs a single slide tuning coil and a variable condenser for tuning.

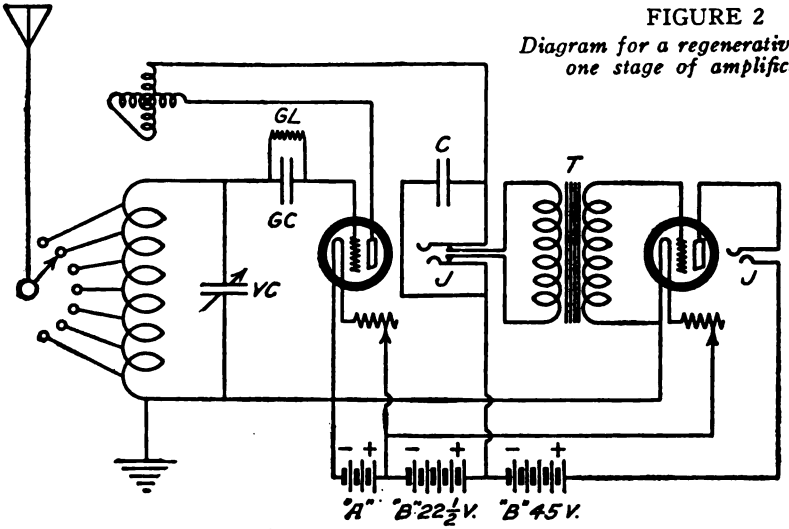


FIGURE 2
Diagram for a regenerative set with one stage of amplification.

QUESTION: Please give me a hook-up for this set: a 43-plate variable condenser, an inductance coil (10 taps), a variometer, an Acme amplifying transformer, two rheostats, two sockets, a Cunningham detector tube, a Radiotron amplifier tube, three "B" batteries, a grid leak and condenser, and an "A" battery.

WILLIAM ENGLE

ANSWER: See the diagram in Figure 2. The antenna tuning is accomplished by means of the taps, the secondary circuit is tuned by the variable condenser VC, and the plate circuit is tuned with the variometer. The first jack is a double circuit jack and the second is a single circuit jack. This circuit will be found to be selective and easy to tune.

QUESTION: Will you give me a hook-up using the two-slide loose coupler, as described in the July issue of POPULAR RADIO? This circuit should also include one fixed condenser, one variable condenser, crystal detector and phones.

RAYMOND LANGLEY

ANSWER: This is shown in Figure 3.

* * *

QUESTION: How can I cut out static on a regenerative set?

JAMES GOOCH

ANSWER: We know of no method of cutting out static entirely. It may be materially reduced by the addition of a single stage of radio frequency amplification to be attached immediately before your present regenerative circuit.

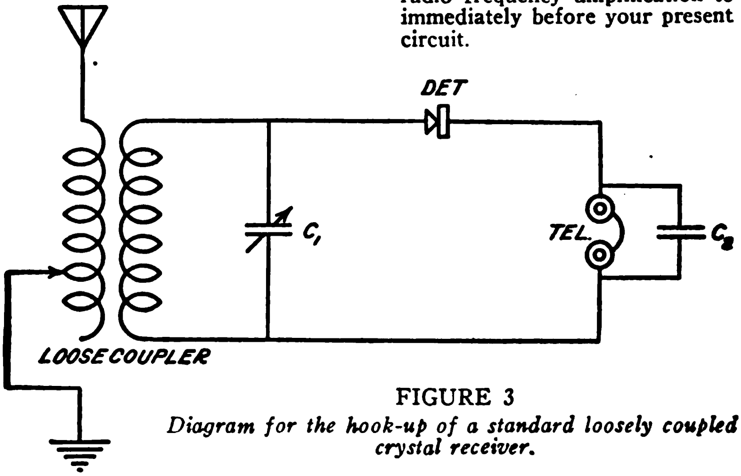


FIGURE 3
Diagram for the hook-up of a standard loosely coupled crystal receiver.

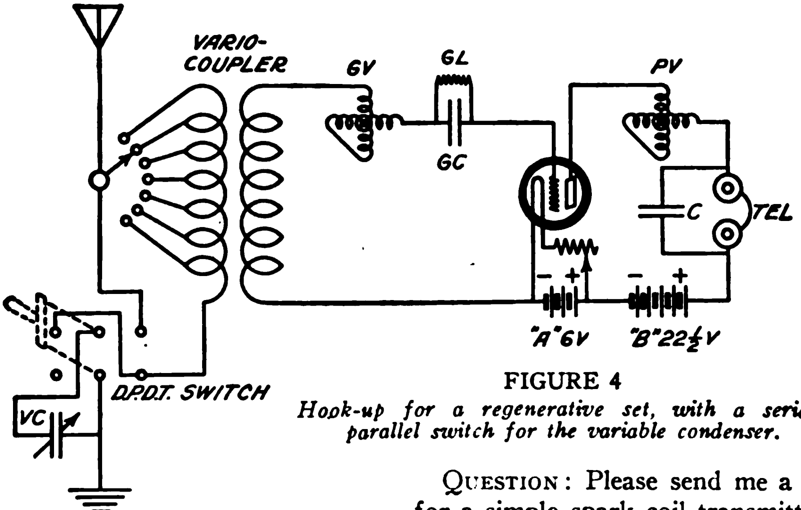


FIGURE 4

Hook-up for a regenerative set, with a series-parallel switch for the variable condenser.

QUESTION: Kindly send me a hook-up for the following: variocoupler, two variometers, variable condenser; also a circuit that shows the connections for a series-parallel switch.

J. A. BEATTY

ANSWER: The hook-up is shown in Figure 4. The variometers are designated as GV and PV, and the grid leak and condenser are marked GL and GC. C is a fixed telephone condenser. The antenna circuit is tuned by the taps on the primary and by the condenser VC. The secondary circuit is tuned by the grid variometer GV, and the plate circuit is tuned by means of the plate variometer PV. The series-parallel switch will be found very effective for changing the wavelength range.

QUESTION: Please send me a hook-up for a simple spark coil transmitter.

R. HARRIS

ANSWER: This set may be made of a Ford coil, and will operate on a few dry batteries. The wavelengths of the transmitted signals are controlled by the two clips on the oscillation transformer. See Figure 5.

* * *

QUESTION: Please give me, by diagram, the best hook-up for a plate and grid variometer, variocoupler, a series-parallel switch for a condenser in the primary of the variocoupler, and a vacuum tube detector. What "ohmage" phones would you recommend?

IVAR SWANSON

ANSWER: Consult the answer to J. A. Beatty and the diagram in Figure 4. Telephones of 3,000 ohms are recommended. This circuit should be very efficient if the instruments you intend using are of a reliable make, and if the set is assembled in a careful and workmanlike manner.

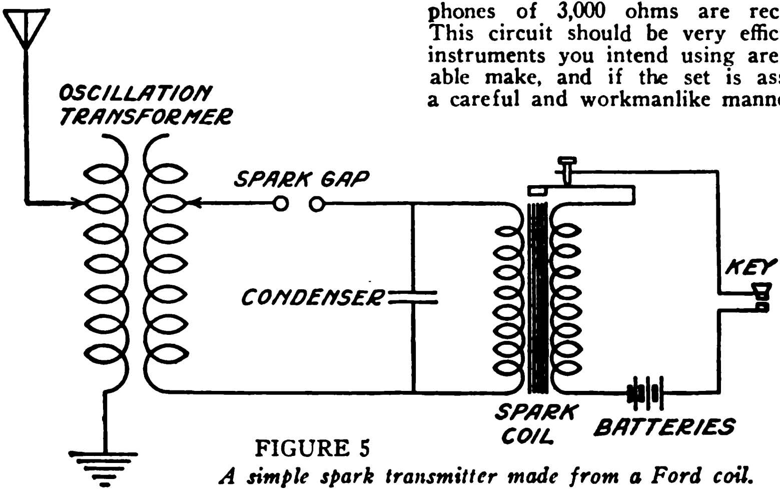


FIGURE 5

A simple spark transmitter made from a Ford coil.

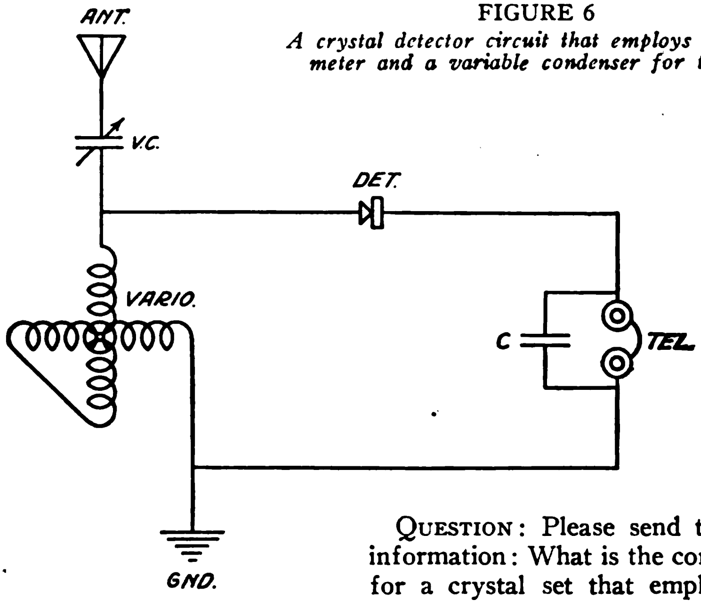


FIGURE 6
A crystal detector circuit that employs a variometer and a variable condenser for tuning.

QUESTION: Please give me a hook-up for a crystal receiving set that uses a variometer and a variable condenser.

WALTER STRANG

ANSWER: Figure 6 gives you the hook-up you require. The secondary circuit is tuned by the variometer, and the antenna circuit is tuned by the condenser and variometer in combination. A fixed condenser C is connected across the telephones. The variometer and the variable condenser both vary the wavelength of the circuit continuously, so that very minute changes in wavelength are possible and interference is reduced to a minimum.

QUESTION: Please send the following information: What is the correct hook-up for a crystal set that employs a variometer, a variocoupler, a fixed condenser, a crystal detector and phones? Would a crystal set that contains these items be helped by the addition of two coils? One coil has 16 taps, (8 turns to a tap), and the other has 11 taps, ranging from 20 turns to 5 turns to a tap.

JACK CLOVER

ANSWER: You may use the hook-up shown in Figure 7. The two coils you speak of would not help you much, but you could improve the set by the addition of a variable condenser connected across the secondary of the variocoupler. This set could be easily changed to a regenerative vacuum tube receiver.

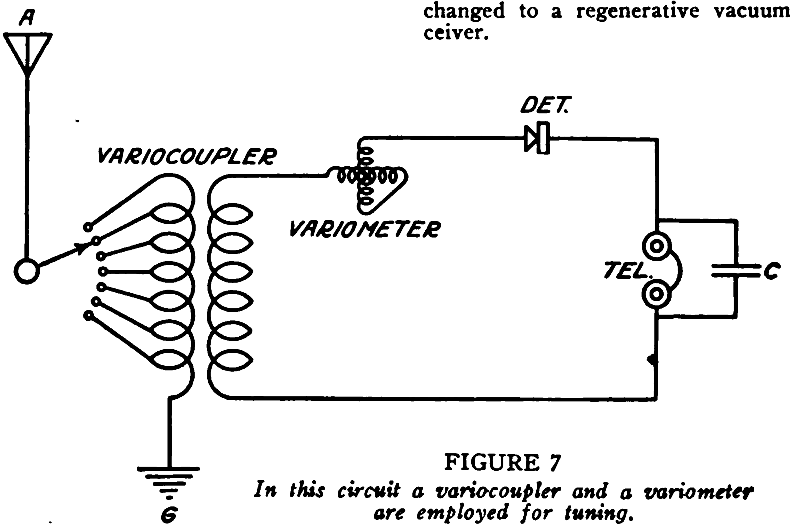


FIGURE 7
In this circuit a variocoupler and a variometer are employed for tuning.

BROADCASTS

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

A Radio Message Averts a Battle

JUST as the British forces were on the point of opening fire on the advancing cavalry of the Turkish Nationalists (which had just occupied Kum Kalesi in the neutral zone), and thus precipitated what in all probability would have been another war, Col. Shuttleworth, of the British forces in Chanak received a radio message from General Harington in Constantinople that gave orders to suspend the attack. Under a flag of truce the representatives of the two conflicting forces parleyed—and the impending battle was avoided.

* * *

A New Radio Set Sells an Old House

UNABLE to dispose of an old house in Dallas, Texas, an enterprising real estate operator installed the very latest radio receiving set in it, and so advertised in the leading paper. From the dozens of offers that poured in he selected one that enabled him to dispose of the property at a good price.

* * *

General Pershing Listens In

THE recent mysterious appearance of an antenna running around the top of one of the big army limousines used by General Pershing gave rise to rumors that the former chief of the A. E. F. had become a radio fan. The installation was made by the general's son, Warren, in collaboration with an obliging army sergeant.

* * *

Connecticut Amateurs Signal to Porto Rico

FOR the first time in the history of radio communication has been established between amateurs in Porto Rico and this country. Messages have been exchanged between the Porto Rico Radio Club and the American Radio Relay League headquarters in Hartford. The first message from the island to the mainland was relayed from San Juan, Porto Rico, to 4FT Atlanta, Ga., thence to 4BX at Wilmington, N. C., and finally to 1QP, J. L. Reinartz, South Manchester, Conn. A return message was transmitted from Hartford to San Juan in the record time of one hour and 27 minutes.

* * *

Radiograms by Wire

THE next time you want to send a message by radio merely drop into (or telephone to) the nearest Postal Telegraph office and enter your order. Arrangements have been completed with the Radio Corporation of America for co-operating in the handling of this traffic.

* * *

The Radio Bug Bites Royalty

Now that the Prince of Wales has joined the ranks of the radio fans and has had a set installed at Windsor Castle, high society in England may no longer hesitate to accept the new art as *de rigeur*. It is even rumored that the Prince has so interested the King and Queen in radio that receiving apparatus may be installed at Buckingham Palace.

* * *

Miniature Radio Sets for Children

THE radio station located in the Eiffel Tower is affecting the toy industry of France, according to M. Lepine, former Prefect of Paris. Little Pierre has lost interest in his tin soldiers and even in his scooter, and is now saving his centimes for a miniature radio set.

* * *

The Human Voice Spans the Atlantic

WHAT is said to be the first authentic record of the human voice being carried across the Atlantic by radio on low wavelengths was made October 6th, when Sir Thomas Lipton spoke from WOR station in Newark and was heard in London by Gordon Selfridge.

* * *

A Radiogram Saves 217 Lives

ANOTHER stirring chapter was written in the romance of radio at sea when the steamship *City of Honolulu* burst into flames while 670 miles off the California coast on October 12th.

Not only did radio keep the world informed of the progress of the fire, but brought help in time to save all of the passengers and crew. Before the days of wireless such a conflagration would have meant suffering and death.

* * *

Grand Opera in an Airplane

THE commercial passenger airplane that flies between Geneva to Paris installed a receiving set this fall and entertained its fourteen passengers with concerts broadcast from Lausaune. It is not inconceivable that members of Parliament, the French Senate and other legislative bodies will soon be enabled to attend the deliberations of their respective organizations, while they are in the air—*they* referring to the members only.

* * *

A Radio Set Squelches a Native Uprising

THE natives of Nyassaland, Central Africa, got their first introduction to radio when the British forces penetrated that territory recently with motor lorries fitted with wireless installations. So terrified were the superstitious blacks with the "machine that could speak without mouth and hear without ears" that they promptly assumed that the god of the ether could listen in even upon their secret whisperings. So they promptly behaved themselves accordingly.

International

A CORKING IDEA

When a press agent tells us that a small wire attached to corkscrew inserted in a flask acts conveniently as a new kind of radio receiver, of course we believe it—not! What the press agent really had in mind was to arouse public curiosity in the exhibits promised for a coming radio show.

* * *

Fighting Floods by Radio

To broadcast warnings of flood, not only for the purpose of summoning aid but also to warn distant residents of impending danger, a radio sending station has been installed near the source of the Verde River in Arizona—the water supply base of a 200,000-acre irrigation project. Radio offers the only means of communication between Phoenix and the upper reaches of the river, where storms often cause enormous damage to the country below.

* * *

Hypnotized through the Earphones

CAN a sane, normal human being be hypnotized by radio? Evidence in the affirmative is offered by Miss Beatrice Kyle, who donned the earphones and permitted herself to be put into a trance for a period of several hours and exhibited on a cot in a store window in Birmingham, Ala. The hypnotist was located at a radio transmitting station several blocks away.

* * *

Radio Substitutes for the School Ma'am

THE project for employing radio for educational purposes is apparently nearer fulfilment in Hawaii than in this country. The superintendent of public instruction in Honolulu has just announced plans for installing radiophones in the rural schools; eventually programs of an educational nature will be broadcast from the headquarters of public instruction. Slowly but inevitably radio is destined to bring the world's greatest educators to the Little Red Schoolhouse.

* * *

A Power Plant in a Suit Case

TESTS recently conducted at the Rocky Point Station of the Radio Corporation of America, prove that the new high-power vacuum tubes are superior to the cumbersome and expensive high-frequency alternators now in use for transoceanic radio communication. A special test set that employed six of the new General Electric Company 20 K.W. tubes, was recently put into transatlantic service, without notifying either the sending operators or the receiving operators on the other side of the world. Neither the foreign operators nor the Americans noticed any difference in the signals, so it is assumed that the signal strength was comparable with the alternator signal, although the antenna current with the tubes was only a little over half that produced by the alternators.

This is a remarkable achievement, particularly when it is borne in mind that the alternators take up almost the center floor space of the huge Rocky Point plant, whereas the tubes which accomplished the same results could almost be put in an ordinary suitcase.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East 40th Street, New York City.*

I Pick Up a Warning From An Unknown Hero

TALES of the exploits of un-named heroes stir the blood and establish one's faith in the innate great-heartedness of the well-known but often maligned Human Race. Here, for example, is a true tale from the sea that comes from an experienced ship's radio operator:

We were steaming ahead through a hurricane such as is only known in the Caribbean Sea and the Gulf of Mexico. The *Grayson,* a typical tramp steamer of small tonnage, was laboring heavily in the fearful weather. Her skipper was a worried man. Shortly after dark he came into the wireless room to ask me if I had received the regular weather forecast from the radio station at Jamaica. I had not heard a thing from that station or any other for over twelve hours, and told him so. He expressed his opinion of me and of wireless operators in general.

"I've got to call at Kingston and it's a tricky harbor," he growled. "I want to know how the wind is going to set me when I make it, and it's up to you to get the reports. The last man always gave them to me and I want you to give them to me."

He slammed the door as he made his exit.

Patiently I tried to pick up some signals which would at least give me an indication that my set was working. I had been thus busying myself for over an hour when suddenly I heard "CQ, CQ," which is the signal for all stations to copy. It sounded like a ship station calling.

"CQ," he continued, "Jamaica is being shaken by terrrific earthquake. Huge tidal wave sweeping Kingston harbor and vicinity."

Then followed a series of unreadable dots and dashes which dwindled into a profound silence. Not another signal, no call letters, no signature was sent.

Breathlessly I carried this missive to the skipper. He read its contents, grunted his surprise and asked, "Where did this come from?"

After I had told him I did not know where it had come from or who had sent it, he again expressed his opinion of wireless operators in general and of me in particular.

I returned to my post in the wireless cabin to listen in for more news, but a silence broken only by bursts of static had again fallen over the Caribbean.

Along toward midnight, the skipper came stamping into the cabin. He had lost some of his gruffness.

"Sparks," he said—and I knew when he addressed me as Sparks that we were on better terms—"are you sure you got this message over the wireless and didn't dream it?"

I assured him.

"Well," he mused, "there is something funny; we should have picked up the light at Kingston over an hour ago, and we can't see it yet."

"Maybe the lighthouse has toppled over," I suggested.

"Maybe," he agreed. "I'm going to haul around and steam offshore, anyway."

At eight bells, we had swung around and were putting out to sea again, and I turned in. The following morning, after breakfast, I got in touch with a British cruiser. He confirmed the dispatch I had received the previous night, and added that the radio station at Kingston had been demolished by the earthquake at noon the previous day. That eliminated the possibility of Kingston having sent that mysterious message.

Where the warning came from and who sent it is still an unsolved problem. Possibly some vessel in the vicinity, equipped with radio, had undertaken to warn off other ships, even though caught in the tidal wave herself. Several vessels were wrecked there at the time. Perhaps some gallant operator stuck to his post in the face of death and sent the warning which saved the *Grayson* and our whole company. But the brave chap evidently never lived to tell the tale or to know of our gratitude.

E. JAY QUINBY

I Deliver a Death Message *via* the Purser

EVERY radio operator who has either received or sent a notice of death can appreciate the feelings of Mr. Hecht—both before and after the fateful message was delivered to the addressee:

While sailing on the Great Lakes as radio operator on the S.S. *Missouri* I received a message from WGO, Chicago. The message was then two days late, and it was the kind that an operator hates to either send or receive. It was worded somewhat like this:

JOHN RYAN SS. MISSOURI
YOUR FATHER IS DEAD COME HOME AT ONCE
SISTER

Instead of giving the message to a cabin boy for delivery in the usual way, I took it to the Purser and explained its contents. He said that he would deliver it in a way that would make it easier than as if Mr. Ryan received it without warning of its contents.

The Purser found Mr. Ryan in his cabin. "The operator just received a message for you; it contains some bad news from your home. Your father is dead."

Mr. Ryan dazedly repeated the Purser's words:

"My father is dead? Why, sure he's dead. He ought to be dead; he died thirty years ago!"

What the Purser said to me will have to go unprinted, and the Chicago radio station received a pointed service message.

R. H. HECHT

A Radio Message Penetrates Prison Walls

TO pick up a bit of news by radio that may save you from an otherwise sure death must give a man convicted of murder an honest-to-God thrill—particularly if that bit of news comes to him in a prison cell, literally within the shadow of the electric chair. This adventure comes from Boston:

When George Rollins, convicted of murder, was listening in on his little radio set on the evening of August 10th, he picked up a piece of information which may bring about his pardon. Rollins was in his cell, listening to the regular late news broadcast from WGI at Medford Hillside, near Boston. Suddenly announcement was made that Governor Sproul of Pennsylvania was to release Frank Smith, alias Jesse Murphy, who had confessed some months before to one of the two murders of which Rollins was convicted. The two killings occurred in February, 1917; no one had yet paid the penalty for them. Rollins and his brother Charles were both implicated and convicted; while George was awaiting sentence, Murphy confessed to one of the murders. While he did not confess to the killing, he positively stated that Rollins did not do it.

Naturally, George Rollins secured a new lease on life when he heard the news by radio that Murphy was about to be released from the Philadelphia Penitentiary and would be brought to justice in Boston.

H. M. TAYLOR

International

Broadcasting Should Benefit the Whole Community

TO THE EDITOR OF POPULAR RADIO:

"The plan you suggest seems to me an excellent one, and I hope will result in distinct benefit to the whole community."

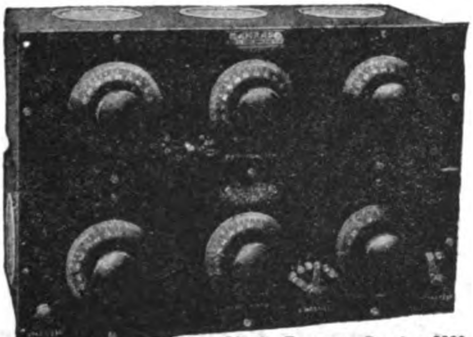
Harry Pratt Judson

President, University of Chicago

Make this a Radio Christmas—
But satisfy with AMRAD

Unless you have heard the AMRAD, you haven't heard Radio. AMRAD Receiving Sets—large or small—incorporate the latest, TESTED refinements only possible after many years of deliberate research and actual Radio engineering and manufacturing experience.

Superior performance, reasonable cost, lasting satisfaction—if your Radio is AMRAD.



Amrad Radio Frequency Receiver 3380

Latest Amrad Quality Receiver, furnished completely assembled in Solid Mahogany Cabinets. Price, less tubes, $125.00

Go to Your Dealer

Ask him to show you the latest AMRAD Receiving Sets, from $21.50 to $300.00. If your dealer is not supplied, place your order, and he will fill it quickly. Look for the green and yellow AMRAD labels in the best stores, and insist on seeing the AMRAD *before* you purchase.

Complete new catalogue describing over 80 Radio Specialties, 10c. in stamps

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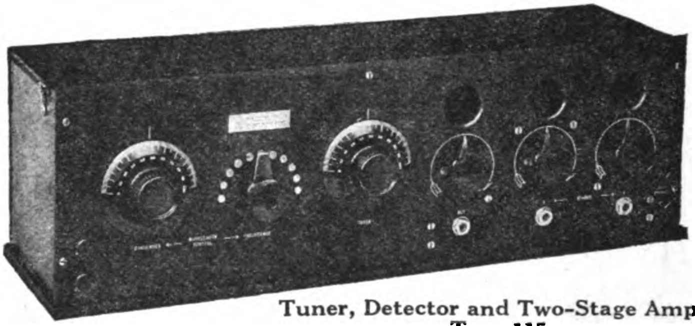
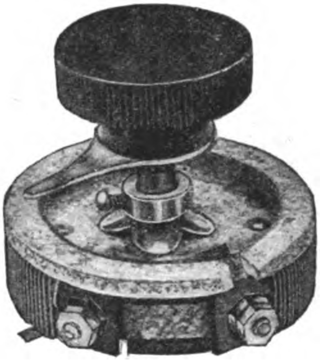


Tuner, Detector and Two-Stage Amplifier
Type 115



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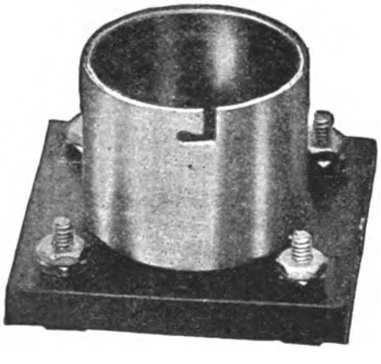

SOCKET
Type 109

DOES years of experience in manufacturing Radio Transmitting and receiving Apparatus for **THE UNITED STATES GOVERNMENT** mean anything to you? **VICTOR** engineers and workmen have had this experience and are capable of producing highly satisfactory Radio Apparatus.

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A WORKRITE CONCERTOLA

FOR THE WHOLE FAMILY

CONCERTOLA JR.

One of these Loud Speakers is just the thing to make Christmas a merry time for the family. "WorkRite" quality means that it will WorkRite. Winter evenings will be short and lively with a WorkRite Concertola on your set.

Except for the phone units, THERE IS NOT THE SLIGHTEST METAL in either the WorkRite Concertola Senior or Junior. The sound chambers of the Concertolas are made from our specially developed material, which reproduces voice or music in a clear, loud tone without the slightest distortion. Just right for the home. Why listen to music through a "tin-panny" metal horn that loses all the beautiful tones of the artists, when you can get a WorkRite Concertola that will give you perfect reproduction of concerts?

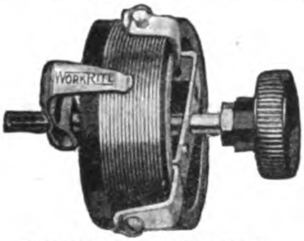
IMPORTANT! A special phone unit has been developed for use in the WorkRite Concertolas. The combination is unequaled. This phone unit will not be sold separate from the Concertolas.

The WorkRite Concertola Senior is built from numerous plies of the finest mahogany, oil rubbed and finished exactly like your piano. It is 10" square by 15" high. Place it on your library table and run wires to your set in any other part of the house.

Test the WorkRite Concertolas side by side with ANY other loud speaker on the market—then you can readily see the superiority of "WorkRites."

WorkRite Concertola Jr. with Cord and Phone Unit, $12.00
WorkRite Concertola Sr. with Cord and Phone Unit, $24.00

CONCERTOLA SR.



PATENT APPLIED FOR

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Here is a Real Rheostat—something entirely new and very much needed. Indispensable on the detector tube when tuning in long-distance concerts or code. Pushing in knob turns off bulb. Quick adjustment anywhere between 6½ ohms and zero. Turn the knob and get 50,000 DIFFERENT ADJUSTMENTS. All metal fittings made from brass and nickeled. Positively Never Gets Hot. The WorkRite Super Vernier Rheostat is really remarkable in its performance and will double the audibility of distant concerts. Price........... $1.50

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We make no big claims for this headphone. All we ask is: TRY THE WORKRITE CONCERT PHONES SIDE BY SIDE WITH ANY ONE ON THE MARKET, even those costing twice as much. Then you will know which is best. Our new sanitary headband is covered with strong celluloid which is easily cleaned. Phone cases made from aluminum. Magnets made and arranged for 100% efficiency. Extremely sensitive and free from distortion. Weight complete with cords only 12 ounces. Try a set and see what a REAL phone is like. PRICE COMPLETE WITH CORD............................ $8.50

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Variometer

Both Rotor and Stator forms moulded of Bakelite. Extremely light in weight. Electrical losses reduced to a minimum.

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The primary Tap Switch for tuning the antenna circuit is an integral part of the Variocoupler. No external switch, shielding, dial, or knob necessary.

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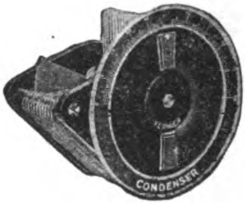
In addition to the units illustrated, other Eisemann products are Head phones, Vacuum Tube Sockets and Audio Frequency Transformers — all made to the highest electrical and mechanical standards.

Variable Condenser

Balanced type

Rigidly constructed. Metal bearings front and rear. Rotary plates balanced, assuring constancy of setting. Vernier equipped.

Capacity .001 mfd.
Price each $7.50



Variable Condenser

Unbalanced type

Aluminum plates accurately spaced eliminating any possibility of "shorts" between plates and assuring a more constant air gap. Vernier equipped.

Capacity .001 mfd.
Price each $7.00
Capacity .0005 mfd.
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A combined Filament Rheostat and Potentiometer, with concave dial which conforms to the design of the parts illustrated, is now in course of preparation.

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To the Radio Public

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The Bel-Canto is built on a new **and patented** principle of radio **acoustics.** The sound is amplified ***without any distortion*** and the tone **is of such** clarity and mellowness as **to surpass** any other amplifying de**vice that** we know of—even those **selling at** $100 or more. Yet the **price of th**e complete Bel-Canto is **only $30.**

If your dealer has not yet stocked **the Bel-Can**to, order direct from the **factory.** We will send postpaid on **receipt of** price or by C.O.D. the **complete in**strument—including spe**cial amplify**ing phone, hard rubber **plug and am**ple cord.

BEL - CANTO CORPORATION
417 E. 34th Street
New York

To Jobbers and Dealers

To give you a free op**portunity to** demonstrate the Bel-Can**to to your** customers and to prove ***by actual*** *performance* in compari**son to any** other loud speaker on **the market** that the Bel-Canto is a **far superior** instrument, we make th**e following** special offer to the trade **only.**

Fill out and mail the **coupon. We** will ship the complete Bel-Canto to you C.O.D.—deducting th**e maximum** discount. Try out this **remarkable** loud speaker. If at the **end of 10** days you are not more th**an satisfied** with its performance, y**ou may re**turn it to us and we w**ill uncondi**tionally refund your mo**ney.**

This special offer is to **the trade** only and is limited to ***one*** **complete** Bel-Canto.

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Bel-Canto Corp., 417 E. 34th St., New York

Gentlemen: Please send me C. O. D. one complete Bel-Canto Loud **Speaker. You** are to refund my money at **the end of 10** days if I am not entirely **satisfied.**

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Marvelous in Performance

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Patents applied for

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BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

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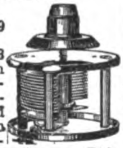
These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS



L824—23 plate .0005 Mfd.
Price $3.79
L826—43 plate .001 Mfd.
Price $4.48

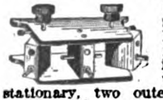
The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

INDUCTANCE "HONEY COMB" COILS

Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	L301	$0.39	L320	$0.97
35	175- 450	L302	.42	L322	1.00
50	240- 720	L303	.49	L323	1.07
75	390- 910	L304	.54	L324	1.12
100	500- 1450	L305	.58	L325	1.16
150	600- 2000	L306	.63	L326	1.21
200	900- 2500	L307	.72	L327	1.30
250	1200- 3500	L308	.78	L328	1.36
300	1500- 4500	L309	.82	L329	1.40
400	2000- 5000	L310	.97	L330	1.55
500	2800- 6100	L311	1.12	L331	1.70
600	4000-10000	L312	1.27	L332	1.85
750	5000-12000	L313	1.43	L333	2.00
1000	7900-15000	L314	1.70	L334	2.38
1250	9750-19500	L315	1.92	L335	2.60
1500	14500-26500	L316	2.18	L336	2.76

COIL MOUNTINGS



L340 Three coil mounting ......$3.95 High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. **L732** Each............86c

This Guarantee Protects You
Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

VACUUM TUBES

Standard Brands—**Cunningham Radiotron.** Every **one guaranteed** new and perfect. We will ship brand in stock unless you specify otherwise.
L105 Detector. Each....$4.45
L110 Amplifier. Each.... 5.95
L115 5 Watt Transmitter 7.70

MYERS TUBES

L113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillates anywhere from 2 to 300 volts on plate. Each $5.00
L116 Receptacle for above. Each... 1.00
L117 Adapter to adapt Myers tubes for use in any standard socket. Each...$1.05

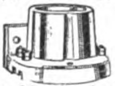
MYERS CHOKE COIL

L119 Each $3.50

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs. **L140** Each............39c

PORCELAIN BASE AND TUBE



L144 Crosley for either panel or table mounting 42c

High Grade combination type for panel or table mounting. Metal tube. Highly insulated base.
L146 Each..............45c

GRID CONDENSER

L162 Mounting holes spaced to fit lugs of above leak. Cap. .00025 MF... ....17c
L163 Same as 162 but higher grade. Enclosed in metalcase 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
L160 Each............21c

VARIOMETER

L410—Completely assembled, price $2.89.
L411—Not assembled but all parts complete, including winding form, $1.90.

Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings. Positive contacts. Highest efficiency.

VARIO-COUPLER

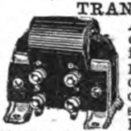
With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.
L415 Price, completely assembled $2.40
L416 Not assembled, but all parts complete. Price $1.35
L417 Rotor ball only. Each........29c

RADIO FREQUENCY AMPLIFYING TRANSFORMER

L995 Each..........$3.50

This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS



As high as three stages can be used without howling, due to proper impedence ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.
L234 10 to 1 Mounted. Each.....$3.69
L235 10 to 1 Unmounted. Each.... 2.95
L236 3 to 1 Mounted. Each...... 3.59
L237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

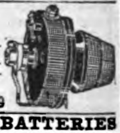
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
L130 Each 54c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¾ in. Knob with pointer.
L132 Each..............48c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
L133 Each........................$1.05

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
L135 Each..........$1.19

PLATE CIRCUIT "B" BATTERIES

You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

L180 Signal Corps type, small size, 15 cells, 22½ volts. Each, 95c.

L182 Large Navy size, 6½x4x3, 15 cells, 22½ volts. Each..................$1.75

L184 Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volts steps. Each............$1.80

L186 Double Navy size 6½x4x6, 30 cells, 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each..$3.40

L188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
L240—100 ft. coil 45c
L242—500 ft. coil $2.16
Solid Bare Copper Wire, size 12
L244—100 ft. coil 61c
L245—500 ft. coil $2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

L248—100 ft. coil 65c
L249—500 ft. coil $2.95

ANTENNA INSULATORS

L260 Size 1x3¼. Two for........19c
L262 Size 2⅛x3¼. Two for.......58c
L264 Size 1½x4. Two for.......80c
L266 Size 1½x10½. Two for $1.35

L260 L262 L264-6

OUTDOOR LIGHTNING ARRESTER

L966 Price........$1.68

Protect your instruments with this lightning arrester. You cannot afford not to. Weather-proof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES

Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

L385 Single Pole Single Throw. Each 20c
L387 Single Pole Double Throw. Each 32c
L384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

L380—1" Radius
L381—1¼" Radius
L382—1½" Radius
Each 22c

SWITCH LEVER STOP

Brass, polished nickel finish.
L386—Dozen 20c. Hundred $1.40

ONE PIECE DIAL AND KNOB

A fine looking knob and dial moulded in one piece. Neat clean cut design. Polished black finish. Clear plain engraved scale with numbers and lines in contrasting white enamel. Ribbed knob that fits the hand. The three sizes used on the same panel can be arranged to produce a very attractive effect.

Three and four inch sizes are marked 0 to 100 and 180° of the scale. 2¼ inch size is marked 0 to 9 over 270° of scale.

L900—2¼ inch Diameter for 3-16 inch shaft. Each............39c
L901—2¼ inch Diameter for ¼ inch shaft. Each............39c
L904—3 inch Diameter for 3-16 inch shaft. Each............49c
L905—3 inch Diameter for ¼ inch shaft. Each............49c
L906—4 inch Diameter for 3-16 inch shaft. Each............59c
L907—4 inch Diameter for ¼ inch shaft. Each............59c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks Only
L390 Open circuit. Each.......45c
L391 Closed circuit. Each.....52c
L392 Two circuit. Each.......63c
L393 Single-cir. fila. control..70c
L394 Two cir. fila. control.....88c

L395 Plug. Large space with set screws for attaching cord. Each............54c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard Jacks and Plugs. Solder connections. Nickel finished metal parts. Fiber barrel on Plug.

L388 Two Circuit Jack. Each.......35c
L389 Standard Plug. Each.........35c

BINDING POSTS

Brass, polished nickel finish. Washer and 6-32" screw extending ⅝"...

L370 Large size—barrel and knob ¾" long, dozen 85c
L372 Smaller size—barrel and knob 9-16" long. dozen 70c

L 370-2 L 376-8

L374 Large size with composition knob. dozen 60c
L376 Large size with hole for phone tip or wire, dozen..........................80c
L378 Small size with hole for phone tip or wire, dozen..........................38c

STORAGE BATTERY

A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.

L194 6-v., 40 amp. size. Each..$10.00
L196 6-v., 80 amp. size. Each..$12.50

Prices are Transportation Paid

Filament Storage Battery

CABINETS

Fine looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	L420	$2.48
6x10½"	5½"	10"	7"	L422	2.75
6x14"	5½"	13½"	7"	L424	3.30
7x14"	6½"	13½"	7"	L423	3.60
7x18"	6½"	17½"	7"	L426	3.90
6x21"	5½"	20½"	7"	L425	3.90
9x14"	8½"	13½"	10"	L428	3.70
12x14"	11½"	13½"	10"	L430	4.40
12x21"	11½"	20½"	10"	L432	5.25

SOLID GENUINE CONDENSITE CELORON PANELS

Notice our very low prices on this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished, Black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x 7	L450	$0.50	L460	$0.75	L470	$0.90
6x10½	L451	.75	L461	1.18	L470	1.47
6x14	L452	1.05	L462	1.55	L472	2.08
7x14	L458	1.20	L468	2.60	L478	2.40
7x18	L453	1.55	L463	2.30	L473	3.10
7x21	L457	1.78	L467	2.65	L477	3.60
9x14	L454	1.60	L464	2.30	L474	3.10
12x14	L455	2.10	L465	3.10	L475	4.15
12x21	L456	3.15	L466	4.65	L476	6.20

BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. Prices are Transportation Paid.

L201 For 6 volt battery............$13.95

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

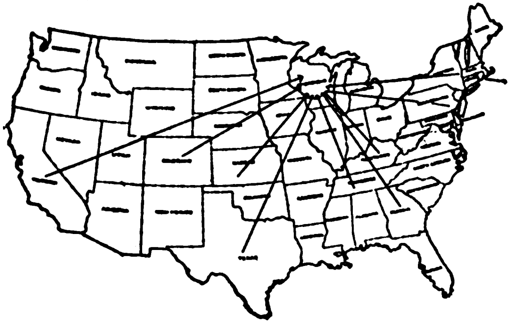
L770—2000 ohm.....$4.00

OTHER STANDARD BRAND HEADSETS

L751 Murdock 56, 2000 ohm $4.45
L752 Murdock 56, 3000 ohm 4.95
L764 Frost, 200 ohm 4.45
L766 Frost, 3000 ohm 5.40
L756 Red Head, 3000 ohm 5.85
L758 Western Electric, 2200 ohm.. 9.50
L754 Baldwin Type C with universal jack plug $16.00
L755 Baldwin Type C unit with attaching cord $7.75
L768 Brandes, 2000 ohm 7.20
L789 Holzer-Cabot, 2200 ohm 7.20

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

Wisconsin "Listens to the world" with MR-6



FROM Wisconsin alone during one month come reports of De Forest MR-6 Receiving Sets getting California, Colorado, Kansas, Texas, Tennessee, Georgia, Kentucky, Pennsylvania, and New York—distances up to 1500 miles. One man listened across the entire continent, getting Santa Cruz, California and Atlanta, Georgia, the same evening. The unsolicited testimonials as to the way this efficient but inexpensive set "listens to the world" are on file in our office and copies will be sent to anyone interested in writing direct to the owner.

Multiply such experiences as these by the thousands of MR-6 sets in use all over the nation—to say nothing of the De Forest Everyman and Radiohome sets—and you get an idea of the way De Forest is serving the nation with the joys of radio.

De Forest manufactures receiving sets all the way from the least expensive to the most elaborate, and laboratory tested high quality parts for those who "build their own." If it's De Forest, it's built in a way worthy to sustain the reputation of that great name.

If you want the best radio has to offer—the songs, the stories, the news of the world—more clearly than you have believed possible and from farther away—you can't go wrong on De Forest!

De Forest Radio Tel. & Tel. Co.
Jersey City, N. J.

DE FOREST

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THE RADIO EXPERIMENTER'S HANDBOOK

By M. B. SLEEPER

Gives wiring diagrams and hookups, explains the theory and operation of damped and undamped transmitting sets, and receiving equipment. The book is profusely illustrated. Tells you the things you want to know about wireless in simple, untechnical language. In this respect, it differs from most radio books in that it tells you what you want to know, and not what the author thinks you ought to know. *16 chapters. Fully illustrated.* Price $1.00.

Other Popular Radio Books

Radio Hook-Ups, by M. B. Sleeper . . $ .75
Indispensable to the radio amateur who designs or builds his own receiving apparatus.

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Gives tables and data for designing, receiving and transmitting apparatus.

Construction of New Types Trans-Atlantic Receiving Set, by M. B. Sleeper 75
Tells how to listen to the high-power telegraph stations of foreign countries.

Construction of Radiophone and Telegraph Receivers for Beginners, by M. B. Sleeper 75
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How to Make Commercial Type Radio Apparatus, by M. B. Sleeper .75
Describes in detail many commercial types of transmitting spark and vacuum tube sets, both telephone and telegraph and receiving equipment of all kinds.

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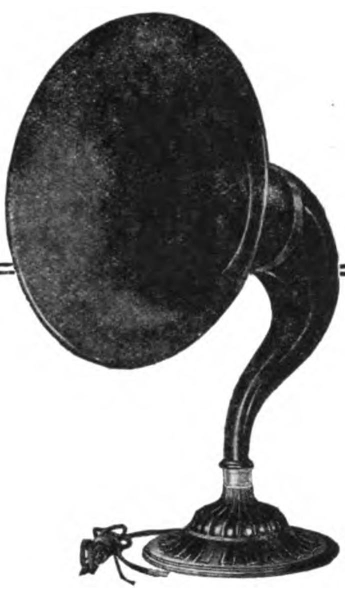
MUSIC MASTER HORN CONQUERS "SCREECH" AND "SNARL" AND "HOWL"



AND MAKES LISTENING A JOY!

ANY up-to-the-minute Radio Dealer will demonstrate this wonderful Horn on YOUR OWN SET. Tune in to your limit and judge the Music Master by what it delivers to your own ears.

Fits any set. No extra batteries, no extra current needed. Makes head sets obsolete. A roomful — a theatre-full! — can listen to any program and hear every cadence, every shading of music or speech, through the Music Master.

Fourteen inch aperture (Home Model) $30
Twenty-one inch (Concert, dancing, etc,) $35

Tell us your dealer's name before you request this free test. Then we can make sure he has Music Master to show you.

JOBBERS — DEALERS

Sample Music Master Horn shipped to responsible members of the Radio or Phonograph trade with FULL PRIVILEGE OF RETURN. Write for list-prices and full details.

"GERACO" LINE

Everything worth selling in Radio Apparatus of TESTED merit. Ask for price lists. See the Geraco Phonograph Attachment. Makes any Victor or Columbia a LOUD SPEAKER for Radio receiving. Use it as sound-box. Only $10.

THE GENERAL RADIO CORPORATION
Makers and Distributors of High-Grade Radio Apparatus
624-28 Market Street, Philadelphia
806 Penn Avenue, Pittsburgh

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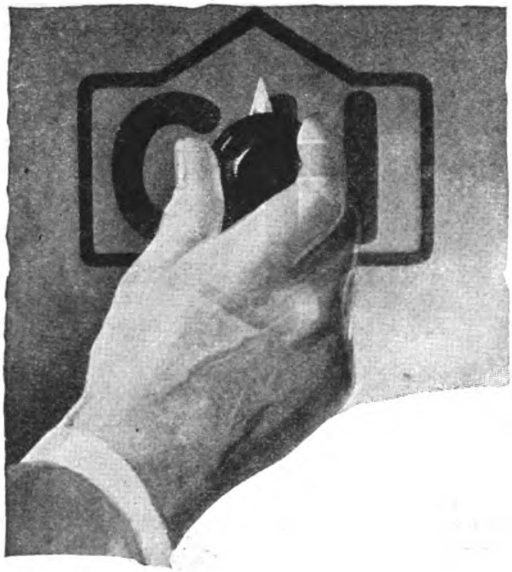
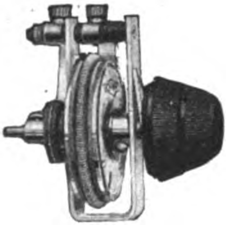
PROVEN RADIO PRODUCTS



Radio Rheostats of Reputation

Protecting every C-H Radio Rheostat stands a guarantee stronger than human hands can write. The decades of persistent and successful development of rheostatic control by the engineers of CUTLER-HAMMER have inspired a faith in their trade-mark that is far too worthy to forfeit.

Engineers the world over accept this mark as unfailing assurance of electrical and mechanical perfection—the signature of approval of the master rheostat builders. It is a protection you should demand in the purchase of your radio rheostat—a device in which precision and reliability are essential.



C-H Radio Rheostats are built in two styles, Type 11601-H1 with vernier adjustment for detector tube control and Type 11601-H2 is furnished without vernier for amplifier tube control. Both rheostats have a range of four ohms with one ampere current capacity.

Type 11601-H1 with vernier... $1.50

Type 11601-H2 without vernier $1.00

THE CUTLER-HAMMER MFG. CO.
Milwaukee, Wisconsin

C-H RADIO RHEOSTATS
"BUILT BY RHEOSTAT BUILDERS"

Like the romance of radio itself

is the story of the phenomenal growth of the company whose name has been linked with radio from the earliest days. Twelve years is a long time in radio—yet over twelve years ago—in 1909, to be exact—William B. Duck began his pioneer work in radio equipment.

Way back in those early days Mr. Duck foresaw with an almost perfect vision the ultimate growth of radio. He was the first and only one to put a "human touch" in a catalog embracing a scientific subject; he realized how largely educational such a catalog must be to accomplish its ultimate purpose—and today, with radio on every tongue, there is in Duck's "Wonder Catalog" an even larger wealth of practical radio information and diagrams than will be found in any of the earlier editions—and in language easy for the layman to understand. It is little wonder that Duck's catalog is universally known as "The Radio Amateur's Bible."

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At All Worth-While Radio Stores
Enquire for Duck Products at Your Dealer's

Embraces 62 instruments—58 parts—the largest and most comprehensive line produced by any radio manufacturer. They should be had at all worth-while retail stores throughout the United States and Canada. In selecting your radio equipment at your dealer's, insist on seeing Duck's products—products that have stood the test of time.

DEALERS

We offer very attractive discounts on our radio instruments. Dealers who carry "Duck" products add prestige to their radio department and create satisfied customers.

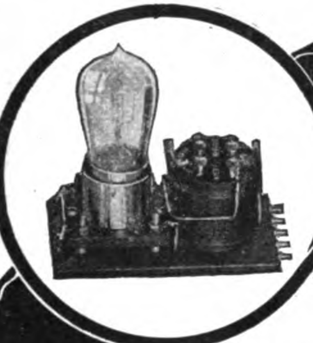
DUCK'S
Big 256-Page Combined Radio Text-Book and CATALOG

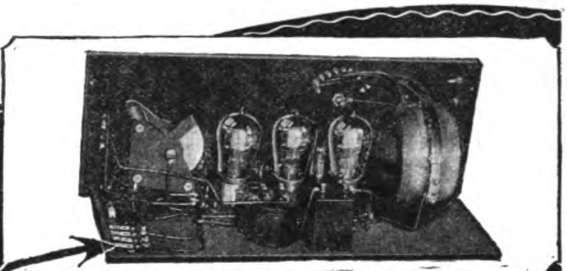
as well as all former editions is now, as in the past, all radio catalogs in one. No other other half so large. It displays not only Duck goods but the products of practically all worth-while manufacturers and contains more up-to-date and practical radio information than will be found in many text-books. Send 25c in coin for this wonderful book—a retainer that hardly pays the cost of printing.

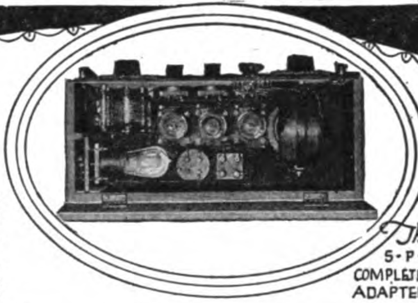
The WILLIAM B. DUCK CO.
227-229 Superior St., Toledo, Ohio
Established 1909

TREMENDOUS DEALER ENTHUSIASM OVER REMARKABLE S-P-2 RECEIVER!

Demonstrated superiority against regenerative receivers, with list price of just $85. Popularity with public, growing in leaps and bounds, makes it the greatest seller on market.







The S-P-2 COMPLETE with ADAPTER

The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

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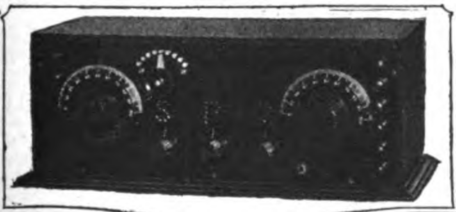
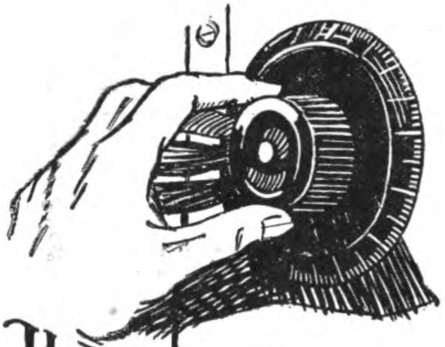
Write for Catalogue 101A



PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Ave. Pittsburgh, Pa.

BELL TELEPHONE
GRANT 3632



How to stop noises when you touch dials

Have you ever noticed in tuning a radio receiving set that when you touch dials, knobs or switches it causes a humming or whistling noise? It is annoying, isn't it? These distracting sounds will disappear if you install dials, knobs and other parts made of

RADION

Tests by disinterested laboratories have shown conclusively that RADION is without exception the best material for radio parts and panels because it comes closest to being the perfect insulation.

Have you tried RADION? If not, secure a dial or other part from your dealer today. Take it home and experiment—that's the best way to become convinced of its unusual qualities.

And while at your dealer's, ask him to show you a RADION Mahoganite panel. Its beautiful mahogany grain will please you. It won't warp and is easy to work. If your dealer cannot serve you, write us direct for all information giving us his name.

Dealers Are Invited to Write for Lists

American Hard Rubber Company
11 Mercer Street New York

REAL RADIO VALUES

Order Direct and Save Money

Look Over These Holiday Specials

	Regular Price	Our Price
Unit Audion Control Panels (Detector)	$ 6.50	$ 5.00
Unit Audion Control Panels (Amplifier)	13.50	10.00
Glass-enclosed Crystal Detectors—less crystal	2.00	1.50
23-Plate Universal Condenser, bakelite ends, .0005 Mfd	4.00	2.50
43-Plate Universal Condenser, bakelite ends, .001 Mfd	5.00	3.00
3-Plate Universal Vernier Condenser, .000246 Mfd	1.50	75c
Keystone Variometers, 150-580 meters	5.00	4.00
6 V, 60-80 Amp. Storage Batteries	16.00	12.00
Open Circuit Jack	.60	.33
Single Circuit Jack	.75	.40
Double Circuit Jack	.90	.48
Double Circuit Jack Filament Control	1.00	.55
Single Circuit Jack Filament Control	1.20	.63
Saturn Automatic Grip Telephone Plug	1.50	.98
Ajax Socket Rheostat	2.00	1.40
Dictograph Headsets, 3,000 ohms	8.00	8.00
Dictograph Loudspeakers	20.00	20.00
Bestone Filament Rheostat	1.00	.60
Bestone Variocoupler, 3-inch dial, 150-600 meters	8.00	5.75
Bestone Variocoupler, 3-inch dial, 150-580 meters	7.00	4.75
Bestone Socket, metal shell, bakelite base	1.00	.75
Federal, Jr. Receiving Sets, Dictograph Headset	25.00	15.00

Everything sent F. O. B. Jersey City the same day we receive your order. Send Money by Registered Mail, Post Office or Express Money Order.

All Goods Guaranteed the Best There Is

HOLMES RADIO PRODUCTS
999-P Bergen Avenue, Jersey City, N. J.

This is station K.S.&S.Co.

Broadcasting

Better Radio Equipment

First—A Short Talk on Kellogg Head Set Superiority

Kellogg head sets are the lightest on the market which is a prime requisite for comfort in any Radio receiving. They are built of highest quality material and their design is based on 25 years engineering experience in telephone receiver construction. Kellogg head sets are supplied under the following codes and resistances: No. 69A, 2400 ohms, including head band and six foot cord; No. 69C, 2000 ohms, including head band and five foot cord; No. 74A, 1000 ohms single receiver with head band and five foot cord. Kellogg head sets are adapted for use by campers with portable receivers.

Second—A Brief Description of Kellogg Jacks and Plugs

Kellogg Radio jacks likewise are a standard product, once installed in your set, will give service and last indefinitely. Hundreds of thousands of Kellogg jacks and plugs in telephone work are in service the world over. They are designed for all standard Radio practice with the following codes: No. 501 is a four-conductor two break type, No. 502 is a two-conductor open circuit type, No 503 is a three-conductor, single break type, No. 504 is a four-conductor, single make contact type, No. 505 is a six conductor, one make, two break type.

Third—Why You Should use Kellogg Grid Leaks and Condensers

Because, first of all, they are accurate—no variation, regardless of atmospheric conditions, insuring uniform receiving.

Fourth—The Reliability of Kellogg Transmitters

Kellogg Company transmitter or microphone is proving exceptionally reliable in Radio work. Today there are over three million Kellogg telephone transmitters in service, and their record is unsurpassed.

Fifth—Kellogg Tube Sockets Are Built of Kellogg Bakelite and a Standard Product Easily Installed, and Reliable

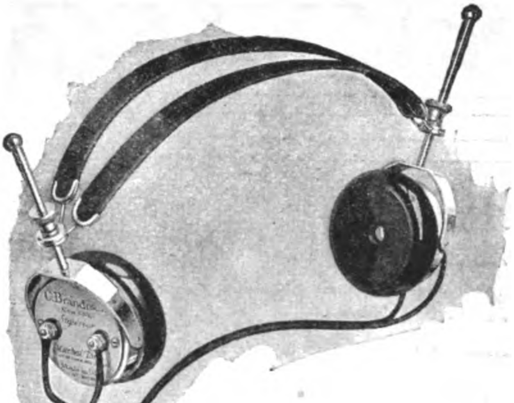
Write us today for our Kellogg Radio bulletin, completely listing our supplies which include insulators, batteries, arresters, etc.; and investigate the latest Kellogg Radio products, every one of which is designed and built on the basis that—Use, is the Test.

Kellogg Switchboard & Supply Co., Chicago

"Signing Off" until Next Issue

"and wishing you a Merry Christmas."

For 25 Years Manufacturers of High Grade Standard Telephone Equipment



What *matched tone* means

COUNTERFEITS strive to duplicate only the best. That is why many headsets are sold with the claim that they are "as good as Brandes."

But to be "as good as Brandes," the phones must be *matched in tone*. Otherwise the listener concentrates on one and the advantage of having two is lost.

Brandes headsets are *Matched Tone* headsets. Hence the faintest sound is heard distinctly by *both ears*.

Reginald Fessenden, the father of the radio telephone, designed the first Brandes headset fourteen years ago. Ever since that time, Brandes *Matched Tone* headsets have been the standard.

Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

Distributors and District Offices:

Munsey Bldg., Washington, D. C.; 709 Mission St., San Francisco, Cal.; 33 South Clinton St., Chicago, Ill.; 76 Pearl Street, Boston, Mass.; 1220 Nicollet Ave., Minneapolis, Minn.; International Electric Company, Wellington, N. Z.

C. Brandes, INC.
Matched Tone Headsets
TRADEMARK REG. U.S. PAT. OFF.
237 Lafayette St., New York
Dept. P.R.

Made in Canada by Canadian Brandes, Ltd., Toronto and distributed by Perkins Electric, Ltd., Montreal

Result of 14 Years' Experience

Compare These Prices

Why Pay More When You Can Get Rock Bottom Prices From Us

$ Save $ Save $ Save

Just glance over our list and send us your money order. Twenty-four hours after receiving your order, it is on its way to you.

List Price		Our Price
$5.00	Radiotrons UV-200	$4.24
6.50	Radiotrons UV-201	5.75
16.00	Baldwins Phones Type C	13.98
7.75	Baldwin Unit Loud Speakers	6.75
45.00	Magnavox	38.00
6.00	Murdock 3,000 ohm Phones	5.00
5.00	Murdock 2,000 ohm Phones	4.25
8.00	Federal 2,200 ohm Phones	6.00
8.00	Brandes Superior Phones	7.00
5.00	Acme Transformers	4.25
1.00	Double Jacks	.60
.70	Single Jacks	.50
2.50	Bull-Dog Plugs	1.25
1.50	100 ft. stranded Aerial Wire	.50
.50	Aerial Insulators	.20
1.00	100 ft. stranded Aerial Wire	.40
75.00	Paragon RA-10	68.00
25.00	90 Ampere guaranteed storage Battery	16.00
8.00	Westinghouse W.D. 11 Tubes 1½ Volt operated on 1 Dry Cell. Can be used as Detector or Amplifier	7.25
1.50	Sockets for W.D. 11 Tubes	1.00
1.00	Rheostats	.75
1.00	Fada Rheostats	.65
1.00	Vacuum Tube Socket	.50
18.50	Homchargers	15.50
3.50	B Batteries Volt Meters o-50 V	2.75
4.50	Murdock Enclosed 43 plate Variable Condensers	4.00
4.00	Murdock Enclosed 23 plate Variable Condensers	3.75
3.25	Murdock Panel Mounting 23 plate Variable Condensers	3.00
4.00	Murdock Panel Mounting 43 plate Variable Condensers	3.60
3.75	23 plate Variable Condensers	2.25
4.75	43 plate Panel Mounting Variable Condensers	2.50
12.00	Western Electric VT-1	7.50
13.00	Western Electric VT-2	8.25
8.00	Atwater-Kent Variometers	7.00
8.00	Atwater-Kent Variocouplers	7.00
4.50	Thordarson Audio Transformers	3.75
1.00	Fixed Condenser	.50
1.50	Crystal Detectors	.75
8.00	3000 Meter Loose Couplers	4.75
4.00	Tuning Coils	2.00
	Contact Points (per doz.)	.15
	Switch Levers 1½ in. Radius	.25
	Honeycomb Coils, All Sizes, 20% Discount	

Space being limited we are obliged to omit many items.

Write for our quotations.

Cut Rate Radio Co.
DEPT. A.
P. O. Box 472 Newark, N. J.

THE MAGNAVOX CO.
A merry Xmas to all the family from Dad

Make it the GREATER Radio Christmas

THE gift of all gifts is Magnavox Radio, the Reproducer Supreme: the gift that will mean most to every member of the family, young and old. Based upon the electro-dynamic principle, Magnavox Radio has no comparison with "loud speakers" which merely combine a megaphone with the ordinary telephone receiver.

R-2 Magnavox Radio with 18 inch horn . .	$85.00
R-3 Magnavox Radio with 14 inch horn . .	45.00
Model C Magnavox Power Amplifier 2 stage,	80.00
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Magnavox Products can be had from good dealers everywhere. Our interesting new booklet (illustrated in three colors) will be sent on request.

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MAGNAVOX

MAGNAVOX RADIO
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HOMCHARGE *your* RADIO BATTERY *for* A NICKEL

Enjoyable Radio Concerts and maximum receiving range are obtained only when your battery is fully charged.

Don't be bothered with the inconvenience and expense of taking your battery to a service station every few days for recharging. The

RADIO HOMCHARGER DE LUXE

has been designed especially for this purpose. It charges your "A" or "B" battery overnight without removing from the living room—gives taper charge—cannot harm your battery in any way. Simplicity itself. Only two wearing parts, replaceable after several thousand hours' use for One Dollar.

AN ORNAMENT FOR YOUR LIVING ROOM

Beauty has been combined with utility in the NEW RADIO HOMCHARGER DE LUXE. The body is beautifully finished in rich Antique Mahogany—the base and fittings in a handsome dull gold. Equipped with rubber feet, it cannot mar polished surfaces. It harmonizes with the finest living room.

OVER 50,000 HOMCHARGERS IN USE

50,000 users have heartily endorsed the HOMCHARGER. Beware of imitations when buying and insist on obtaining the genuine which bears our registered trade name, HOMCHARGER.

Furnished complete. No extras to buy. Price $18.50 (25.00 in Canada) at all good dealers, or shipped prepaid upon receipt of purchase price.

Booklet illustrating the NEW RADIO HOMCHARGER DE LUXE in actual colors is FREE for the asking. Send for your copy today.

DEALERS—JOBBERS: Over 150,000 HOMCHARGERS will be sold this fall and winter. Send for your copy of "HOMCHARGER Business Builders" and see how you can get your share of this business.

CAUTION

When buying a Rectifier insist upon the following:

1—SELF-POLARIZING FEATURE, otherwise your battery may be ruined through reverse charging.

2—AT LEAST FIVE AMPERE CHARGING RATE, otherwise it will require several days to fully charge your battery.

3—UNDERWRITERS' APPROVAL, otherwise in case of fire your insurance may be void.

The HOMCHARGER is the only Rectifier *at any price* which combines the above three NECESSARY HOMCHARGING features.

The Automatic Electrical Devices Company

132 West Third St., CINCINNATI, O.

Largest Manufacturers of Vibrating Rectifiers in the World

BRANCH OFFICES:
New York Chicago
Philadelphia Detroit
Los Angeles Dallas
Pittsburgh Baltimore
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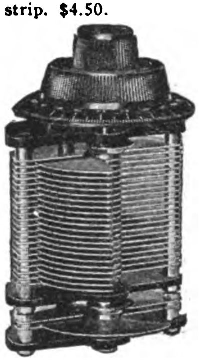
TYPE "A" FOR WALL MOUNTING — OVER 50,000 IN USE —

PLAY SAFE! INSIST ON GETTING "UNITED" RADIO PRODUCTS

Follow the example of the Radio-wise experts who buy each part with an exact knowledge of its true value.

United Transformers amplify weak sounds; bring in distant stations; with clear, pleasing distinctness.

A beautiful piece of workmanship with sturdy steel shell, furnished in black enamel with buffed nickel strip. $4.50.



United Variable Condensers

Correct in design, high grade in workmanship. Plates are held positively, so that short-circuiting is practically impossible.

LIST PRICES

43 plate..	$4.50	5 plate..	$2.75
23 plate..	4.00	3 plate..	2.25
11 plate..	3.50	without dial or knob.	

United Variable Condensers, with Vernier Attachment Dial and Knob.

46 plate..$6.50 26 plate..$5.50

United Transformers and Condensers have been adopted as standard equipment by leading makers of radio receiving sets. Their judgment is a safe guide for you.

Tell your dealer you want "United" or nothing. Circular free.

UNITED MFG. & DISTRIBUTING CO.

536 LAKE SHORE DRIVE—CHICAGO

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF POPULAR RADIO

Published monthly at New York, N. Y., for October 1, 1922.

STATE OF NEW YORK }
COUNTY OF NEW YORK } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kendall Banning, who, having been duly sworn according to law, deposes and says that he is the Editor of Popular Radio, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Popular Radio, Inc., 9 East 40th St., New York City; Editor, Kendall Banning, 9 East 40th St., New York City; Managing Editor, None; Business Managers, Popular Radio, Inc., 9 East 40th St., New York City. 2. That the owners are: New Fiction Publishing Corporation, 9 East 40th St., New York City; Metropolitan Finance Corporation, 9 East 40th St., New York City; Medbury Blanchard, 500 Fifth Ave., New York City; Le Roy Sargent (only stockholder owning 1% or more of stock of Metropolitan Finance Corp.), 9 East 40th St., New York City. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are; None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) KENDALL BANNING, Editor.

Sworn to and subscribed before me this 18th day of September, 1922. [SEAL] EUGENE S. BIBB, *Notary Public*.

The SANDMAN'S STORY

Catalog Number Four contains Marvelous article on tuning Receiving Sets. 10 cents brings it to you

On a Tuska Radio Receiver, every evening you can hear "The Sandman's Story". This delights the children. Later comes entertaining Radio Broadcasting for grown-ups.

Tuska Radio will bring dependable broadcasting into your home, A Tuska Radio Receiver makes a wonderful Christmas Present.

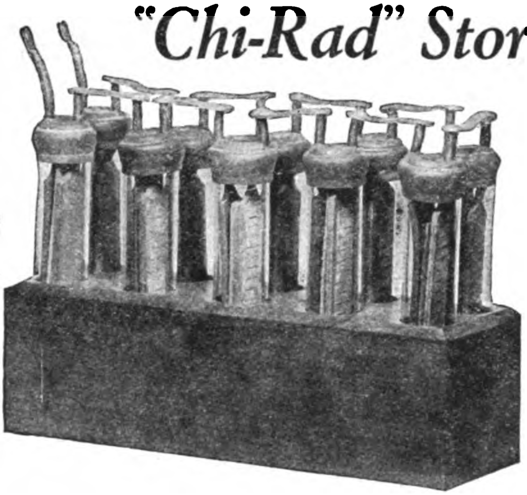
Tuska Radio is substantial, reliable, dependable and recognized. Inspect today at your dealer's.

THE C. D. TUSKA COMPANY
Bartholomew Ave. Hartford, Conn.
Pacific Coast Office, 711 Mission Street, San Francisco, Calif.

TUSKA RADIO

Established 1911

"Chi-Rad" Storage "B" Battery—



built for service. Absolutely unequaled in quality and price—half the cost of the cheapest well-made storage "B" battery. Better and cheaper than dry cell "B" batteries because rechargeable.

Will operate a tube approximately 1,000 hours on a single charge. Recharged overnight with "Chi-Rad" Storage "B" Battery Charger at a cost of about 5c.

No noises or leakage losses with "Chi-Rad" Storage "B" Batteries. Guaranteed for service, or to be returned at our expense. Order your battery *now*.

Write for your free copy of our new catalog.

No. 102 "Chi-Rad" Storage "B" Battery

22½ volt section (mounted) . .	$6.00
2½ volt section (single cell) . .	.50
No. 102*a* "Chi-Rad" Storage "B" Battery Charger	1.90

(ORDER BY NUMBER)

Dealers—Write for territory on "Chi-Rad" Radio parts and sets.

Chicago Radio Apparatus Co.
415 South Dearborn Street :: Chicago

The Only Knob and Dial Without a Set-screw

The unsightly and troublesome SET-SCREW is at last eliminated. No more splitting the head of the set-screw or stripping of threads, perhaps ruining the dial.

To mount the TAIT-KNOB-AND-DIAL simply hold the dial with one hand and screw on the knob with the other; a few seconds does it. No tools are necessary. When fastened it is self centering and self aligning.

This beautiful patterned KNOB-AND-DIAL is made of the best grade of BAKELITE.

To those building their own sets—Don't fail to use this dial, it is REVOLUTIONARY in its field and is the PEER of all KNOBS-AND-DIALS. If your dealer has none, write us and we will refer you to one who has.

Dealers—If your Jobber is not stocked up, write us and we will refer you likewise.

List price—4" model $1.50; 3" model $1.00

We Sell Strictly to Manufacturers and Jobbers—whom we invite to write us for samples and discounts.

Patented June 20, 1922.

TAIT KNOB & DIAL COMPANY, Inc.
11 East 42nd Street Dept. P. New York

START RIGHT AND CARRY ON

With **James R. Cameron's**

"TEXT BOOK ON RADIO"

HOW to build your own set, from crystal to Super-regenerative.

WHAT to use.

Profusely illustrated.

The finest coat pocket, flexible bound "TEXT BOOK ON RADIO," with a complete List of "Radio Terms" and Classified Index.

CLOTH BOUND : :	**$2.50**
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"RADIO'S THREE BEST SELLERS"

Radio for Beginners . .	*$1.00*
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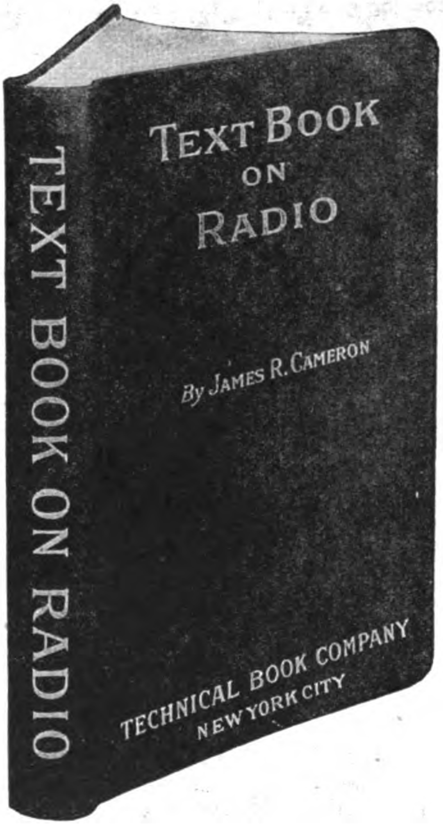
How to Build Your Own Set	*.25*



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GENTLEMEN—Kindly enter my order for the following:

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Street..........

City and State..........

TECHNICAL BOOK CO.

130 West 42d Street Dept. P New York

THESE RADIO SUPPLIES ARE YOURS THEY COST YOU NOTHING!

We will give you cost-free any of the radio supplies listed on this page without its costing you a single penny. You have only to show your December copy of POPULAR RADIO to a few friends. Tell them this number is only one of twelve corking good issues, the best Dollar-And-A-Half buy in the market. They'll subscribe!

You may have any number of articles provided you have the necessary subscription credits. Here's an idea that will help you get them: A subscription to POPULAR RADIO makes an ideal Xmas gift both on account of its *suitability* and its extremely *low price*. It's the one gift that lasts for a whole year.

FILAMENT CONTROL RHEOSTAT

It is used for controlling the brilliancy of a vacuum tube so that the utmost efficiency may be obtained from your receiving set.

Send two (2) yearly subs at $1.50 each.

VACUUM TUBE SOCKET

A vacuum tube socket of this sort is very necessary in all receiving sets that employ tubes. Have you one?

Send two (2) yearly subs at $1.50 each.

MICA GRID CONDENSER

You may have either a mica grid condenser or else a phone condenser. Either makes a thoroughly efficient device needed in receiving circuits.

Send two (2) yearly subs at $1.50 each.

A RADIO READING COURSE

This course comprises five illustrated lecture books, approved and edited by Prof. J. M. Morecroft of Columbia University—an elementary study of radio.

Send three (3) yearly subs at $1.50 each.

TWO INDUCTANCE COILS

Inductances for use in the new Armstrong super-regenerative circuit. They consist of two Duo-Lateral or Honey-Comb coils, Nos. L-1250, and L-1500.

Send eight (8) yearly subs at $1.50 each.

VACUUM TUBE U-V-201

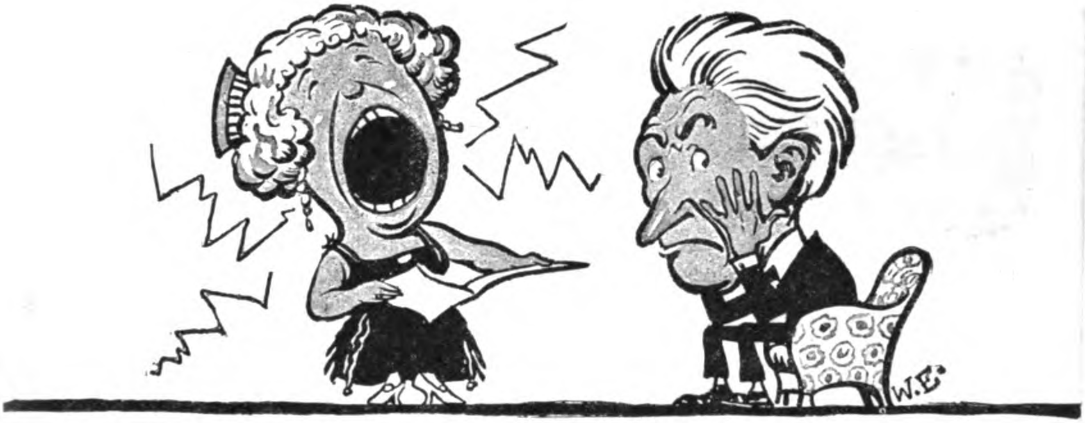
The vacuum tube U-V-201 can be used in a receiving set for rectifying or amplifying. It is more efficient than the crystal detector.

Send ten (10) yearly subs at $1.50 each.

IMPORTANT: Full remittance must accompany each order. An additional charge of $.25 postage for Canada and $.50 for each foreign subscription is necessary. Please specify what you want when you send your order. This offer is not good after January 15, 1923.

POPULAR RADIO, Inc.

9 East 40th Street New York City

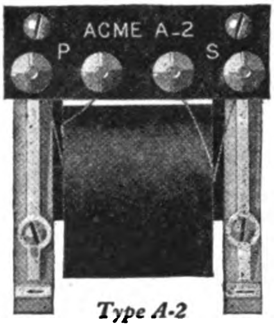


"Can those shrieks"

HOW often have you sat helpless while some amateur Farrar has tried to hit "High C." But when your radio set starts in to show off its shrieking talent you need not go through another ordeal. Just drop in at your nearest radio store and order an Acme *Audio* Frequency Amplifying Transformer. Hook it up to your detector set and sit back easy. You'll be surprised how clearly and distinctly incoming sounds may be heard. Then, too, the tones are natural. Something usually so lacking in the ordinary set.

You will also want the Acme *Radio* Frequency Amplifying Transformer because this will greatly increase the range of your set whether it be vacuum tube or crystal detector. Both Acme *Audio* and Acme *Radio* Frequency Amplifying Transformers sell for only five dollars. Your set is not complete without them.

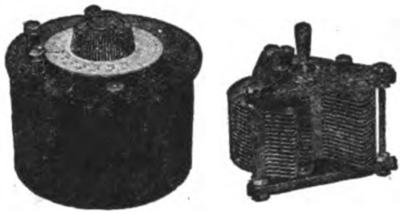
The Acme Apparatus Company (pioneer transformer and radio engineers and manufacturers) are also manufacturers of one and two stage amplifying units, detector units, detector and two stage amplifying units, the Acme Clear Speaker, the Acmefone. Acme C. W. and spark transmitting apparatus offer the amateur an opportunity to not only receive but send his own messages. For sale at radio and electrical stores or write direct to the Acme Apparatus Company, Cambridge, Mass., U. S. A., or New York Sales Office, 1270 Broadway. Ask also for instructive free booklet on the operation of amplifying transformers, both audio and radio frequency types. You need it.



Type A-2
Acme Amplifying Transformer
Price $5 (East of Rocky Mts.)

ACME

for amplification



TYPE 247 CONDENSER

DESIGNED NOT MADE

Would you buy diamonds at a corner grocery store? Of course not; you do not expect the grocer to be a diamond expert! Then why buy condensers that are simply made instead of being designed?

For many years the GENERAL RADIO COMPANY has been supplying the research and educational institution laboratories throughout the country with radio apparatus of the highest quality. The Bureau of Standards and other government laboratories are extensive users of our equipment. The experience obtained in this line has enabled us to design instruments for the citizen radio field that represent the latest developments in engineering and mechanical skill.

For seven years we have been supplying radio condensers that have been a standard for low losses and excellency in construction. Our latest addition to this line of condensers is the type 247. Send for Free Radio Bulletin 911-U and learn why these condensers are so popular.

MODERATELY PRICED AS FOLLOWS:

Type 247A— .001 M. F. Mounted, Shielded....Price, $6.00
Type 247B— .001 M. F. Unmounted, with Counterweight....Price, 3.75
Type 247E—.0005 M. F. Mounted, Shielded....Price, 5.56
Type 247F—.0005 M. F. Unmounted, with counterweight....Price, 3.25

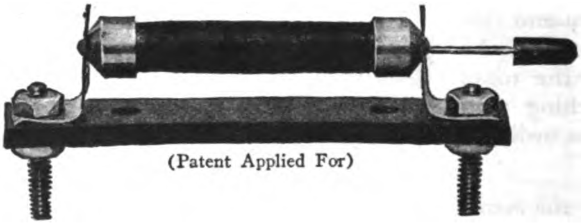
This condenser is but an example. We manufacture a complete line of the finest radio instruments and parts.

GENERAL RADIO COMPANY

Massachusetts Avenue and Windsor Street, CAMBRIDGE, 39, MASSACHUSETTS

Standardize on General Radio Company Equipment Throughout.

Do not confuse the products of the GENERAL RADIO CO. with those of the other concerns using the words "General Radio." The General Radio Co. has been manufacturing radio and scientific instruments for many years. It has no affiliations with any other company.



(Patent Applied For)

THE ONLY ONE IN AMERICA

With the usual type of "Grid Leak," which is of fixed value, it is necessary to try a number of them to determine the one best suited.

The Durham Variable High Resistance

(Adjustable Grid Leak)

is the only one of its kind now on the market, because it is *adjustable* over a wide range and will maintain its value permanently after initial setting—It is non-inductive and has negligible capacity.

Made in two sizes:
No. 100—1,000 to 100,000 ohm range
No. 101—100,000 to 5,000,000 ohm range

Wire or write for samples and prices to

DURHAM & COMPANY

1936 Market Street ***Radio Engineers*** **Philadelphia, Pa.**

That Satisfying Pride in Your Radio Set

You know how it is when you own anything that is really fine. You're proud of it and jealous for it and want others to appreciate it as you do. You'll feel in full measure that satisfying thrill of pride in your radio set when you own Kennedy equipment. Even such friends of yours as are not radio "fans" will admire the handsome appearance and perfect finish of your Kennedy installation. And those who are radio experts will be even more enthusiastic over its splendid performance.

KENNEDY EQUIPMENT

The Beautifully Finished and Wonderfully Efficient

KENNEDY

***Short-wave Regenerative Receiver Type* 281**

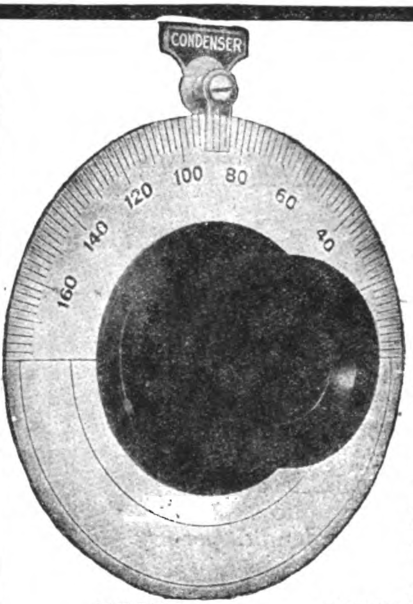
An ideal set for general use. Highly sensitive, selective and efficient—easy to operate—finely made in every detail. Meets the requirements of keen radio students who recognize and demand the best. Yet it is so simple to use that perfect results can readily be obtained by novices. Ask your dealer to show you the Kennedy Type 281 Regenerative Receiver, and *write* our nearest office for latest Kennedy Bulletin C-3.

All Kennedy Regenerative Receivers are licensed under Armstrong United States Patent No. 1,113,149

THE COLIN B. KENNEDY COMPANY
INCORPORATED

SAN FRANCISCO **U. S. A.** **SAINT LOUIS**

KENNEDY
EQUIPMENT



SOMERVILLE

STANDS FOR

DISTINCTIVE APPEARANCE AND OPERATING CONVENIENCE

The THREE-IN-ONE DIAL places it beyond competition. The price is based on huge production.

FIRST Silver lacquered brass dial contrasts with Black Panel. The knob fits the fingers without fatigue.

SECOND Lower half of scale may be calibrated in meters or station call letters with pencil.

THIRD The tail of dial tag makes contact with back of dial and connects with ground, removing hand capacity.

SOMERVILLE DIAL TAGS 5c.

Completing the line of terminal and Jack tags

Makes your metal dial a shield and tells you what's what; with the celluloid pointer at 10c adds the finishing touch to your set.

ALL READINGS AVAILABLE

PRICES

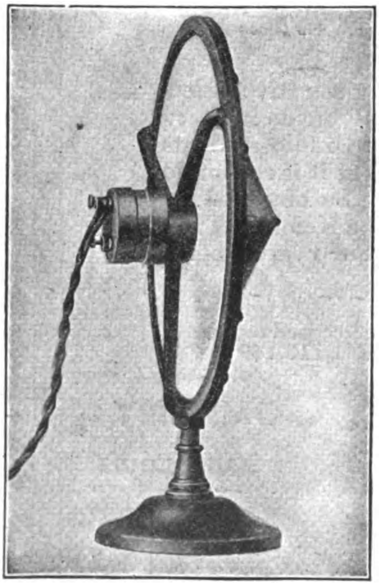
4-in. Dia. Dials. . .	**$1.50**
3¼-in. Dia. Dials.	**1.00**
1¾-in. Dia. Dials.	**.60**

Specify ¼-in. or 3/16-in. Shaft Hole.

SOMERVILLE RADIO LABORATORY EST. 1917

43 CORNHILL, BOSTON

NEW CATALOG NOW READY—WRITE



THE PATHÉ LOUD SPEAKER

Has No Superior

It reproduces exactly the sound sent out and has none of the "tinny" noise that must come from a metal horn. It operates with any two stage amplifying set. Insist on hearing a Pathé operate before you buy.

Price, $24

THE SOUND WAVE CORPORATION

30 Grand Avenue, Brooklyn, New York

Makers of Quality Dials, Variometers, Variocouplers, and Loud Speakers

DICTOGRAPH Radio HEAD SET

Was $12.00 Now $8

Why This Sensational Reduction in Price?

A SWEEPING cut of $4.00 in the price of the Dictograph Radio Head Set! The tremendous endorsement of radio enthusiasts has made possible this sensational reduction. To meet the demand, production has been planned on a new, gigantic scale. Great manufacturing economies establish the new price—only $8.00 complete with 5 ft. cord.

A wonderful bargain! And, above all, a wonderful head-set—the world's standard of supreme quality for super-sensitive and accurate sound-transmission.

The same quality, the same guarantee, the same supreme Dictograph head-set in every respect but the price. Type R-1, 3,000 ohms, for all types of receiving sets.

The Standard of the World

Note: Plans are now under way for the production of the new 4,000 ohms Dictograph SUPER-TONE Head Set, the most perfect radio head set that can be made. For the most delicate work, the most exacting requirements. A new standard of super-sensitiveness! List Price, $12.00.

DICTOGRAPH Radio LOUD SPEAKER $20

The Perfect Loud Speaker for the Home

Public demand has made possible the Dictograph Loud Speaker at the low price of only $20.00, complete with 5 ft. flexible cord. A handsome instrument that reproduces every sound in crystal-clear, natural tones, full volume, and free from distortion or noise. Ask for demonstration at reliable radio dealers. Get world-famous DICTOGRAPH quality and still save money.

Dealers: Order through your jobber or write direct for names of authorized distributors.

DICTOGRAPH PRODUCTS CORPORATION
220 West 42d Street (Branches in all Principal Cities) New York, N. Y.

WARREN
Specialists in Head Sets and Loud Speakers

Delight of Perfect Broadcast Reception

is Found in the

Warren Phones

THE WARREN is indeed a Head Set which, at anything like equal price, cannot be equaled for sensitiveness, articulation and clearness, or in all around excellence of design and construction.

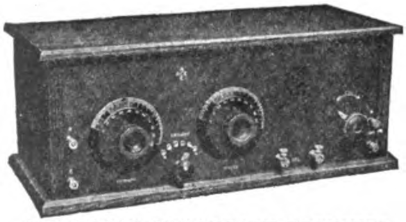
2000 Ohms $7.00
3000 Ohms $9.00

ASK YOUR JOBBERS—OR WRITE US

Attractive Discount to Jobbers and Dealers

WARREN RADIO PHONE MFG. CO., Inc.
Warren, Rhode Island, U. S. A.

Is It Hard to Choose a Christmas Present for the Boy?



ACE RADIO BROADCAST RECEIVER
Licensed under
Armstrong U. S. Patent
No. 1,113,149

IF he has real red blood in his system, he will want a radio broadcast receiver, or the parts with which to make his own.

Start him right in this fascinating new field—give him an ACE Radio Concert Receptor or ACE Radio parts. Incidentally you will enjoy Radio as well as your boy.

Let us send you our descriptive booklet, "Radio In Your Home."

THE PRECISION EQUIPMENT COMPANY
2437-2439 Gilbert Avenue *Dept. XM* Cincinnati, Ohio

—And a Flock of Radio "Bugs" Step Up to Broadcast Their Christmas Orders!

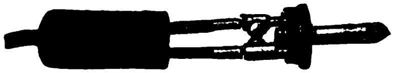
Three million eager American boys know that this year Santa won't have any excuse for mistaking their orders on account of poor writing. Billie, last year got a Doll and he wrote for a Ball! Santa's Frost-Fones are a guarantee of clear accurate Radio reception. They will bring satisfaction to thousands of homes through their dependable service.

No. 162
2000 Ohm
Set.. $5.00

No. 163
3000 Ohm
Set.. $6.00

Something New—A Plug for 60c

No. 139
All Terminal Plug
60c



Showing screw binding post terminals with phone cord tips inserted

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Frost-Radio Leaders

Frost-Radio Protector—Frost-Radio Tuning Coil
Frost-Radio Extension Cord and Plug
Frost-Radio Improved Jacks and Plugs
Frost-Radio Receiving Transformers
Frost-Fones—Cunningham Tubes
Remler Radio Apparatus

Your local dealer can supply you

Like Postage Stamps Used Everywhere
FROST RADIO
154 W. LAKE ST.
CHICAGO, ILL.

HERBERT H. FROST
NATIONAL FACTORY DISTRIBUTORS
TO THE ELECTRICAL-RADIO JOBBER
154 W. LAKE ST. CHICAGO, ILL.

Dubilier Micadons reduce tube noises

Tubes howl partly because condensers fluctuate in capacity. Dubilier Micadons are *mica* condensers which are *permanent in capacity.* Hence they reduce tube noises and greatly improve reception. Dubilier Micadons are made in several types to meet every radio need. The price varies from 35c to $1.00 each, depending on the type and the capacity.

Micadon type 600. Molded case. With and without grid-leak mounting. Prices range from 75 cents to $1.00 each, depending on capacity.

Micadon type 601. Connect by eyelet terminals to build up desired capacity. Price 35 cents and 40 cents each, depending on capacity.

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San Francisco............709 Mission St., Suite 701-704
St. Louis, Mo.........Syndicate Trust Bldg., Suite 1409
Washington, D. C.......................Munsey Bldg.
Chicago, Ill..........................33 S. Clinton St.
Atlanta, Ga.......................802-3 Forsyth Bldg.

DUBILIER
Condenser & Radio Corp.
48-50 West 4th St. N.Y.

Canadian Distributors: Canadian General Electric Co., Toronto, Can.

Give him a PACENT MULTIJACK $1.50

Your radio friend or relative will appreciate a gift of one or more PACENT MULTIJACKS (three independent jacks in a single base). Then three can listen in. Ask your dealer to show you PACENT products and look for the PACENT trade mark. *Send for descriptive bulletin, PR106*

PACENT ELECTRIC COMPANY
INCORPORATED
Executive Offices: 22 Park Place, New York, N.Y.
BRANCH OFFICES
Philadelphia — Washington, D. C.
Chicago — San Francisco

"This is a RADIO Christmas"

NOVO
"B"
BATTERIES FOR RADIO
22½-45 & 105 VOLTS

NOISELESS
DEPENDABLE
GUARANTEED

ASK YOUR DEALER

NOVO. MANUFACTURING CO.
424-438 W. 33rd ST
NEW YORK
531 SO. DEARBORN ST., CHICAGO.

CHELSEA CONDENSERS

NO. 1

PRICES

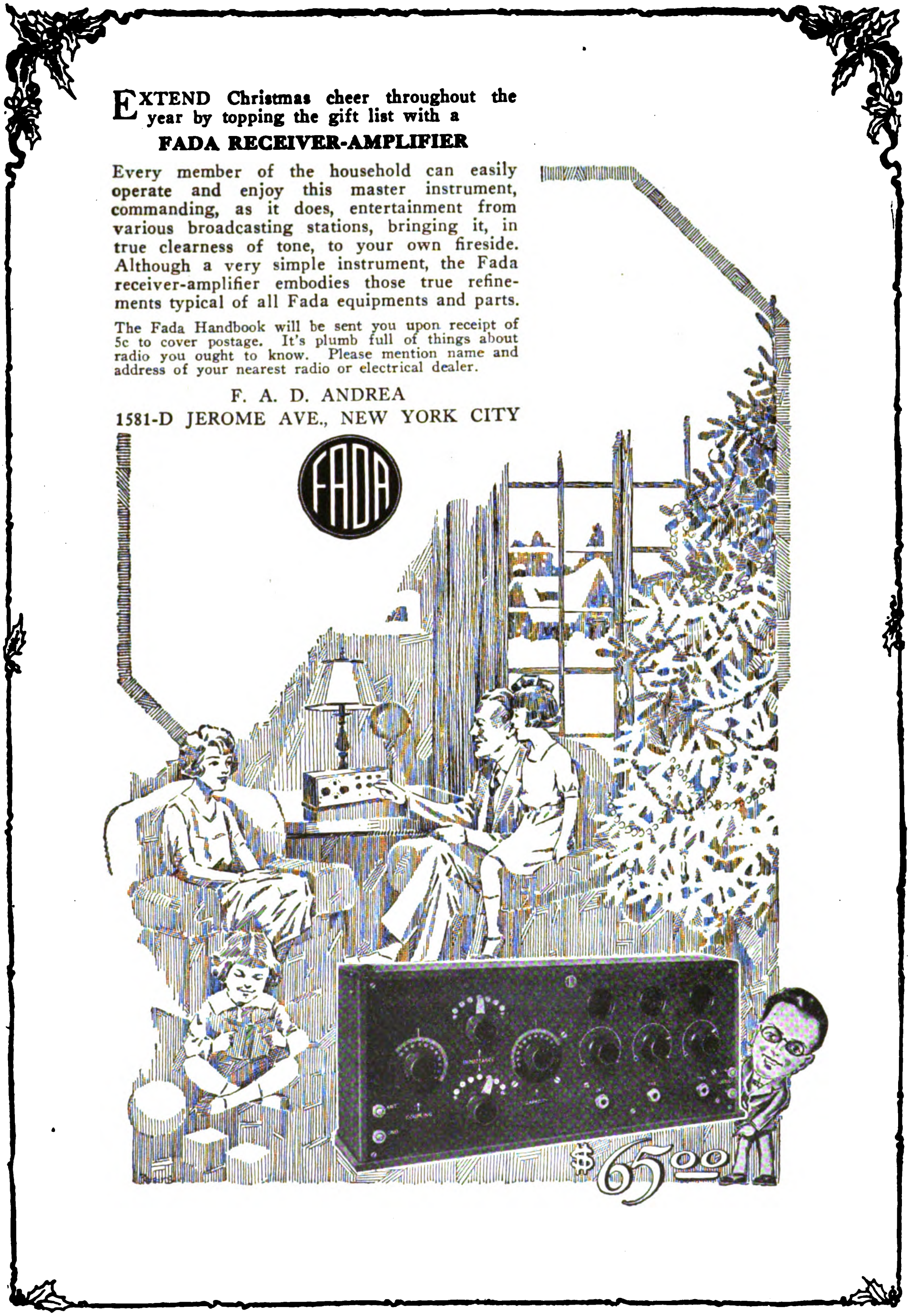
No. 1	Table .001	$5.00
No. 2	Table .0005	4.50
No. 3	Panel .001	4.75
No. 3a	Panel without dial	4.35
No. 4	Panel .0005	4.25
No. 4a	Panel without dial	3.85
No. 5	Panel .00025	3.75
No. 5a	Panel without dial	3.35
No. 6	Panel vernier	2.90
No. 6a	Panel without dial	2.50
No. 7	Panel with vernier	6.50
No. 8	Table with vernier	6.75

GENUINE BAKELITE CONSTRUCTION

The best and most complete line of condensers in existence.

Write for our catalogue No. 7.

CHELSEA RADIO COMPANY
177 SPRUCE STREET — CHELSEA, MASS.



EXTEND Christmas cheer throughout the year by topping the gift list with a

FADA RECEIVER-AMPLIFIER

Every member of the household can easily operate and enjoy this master instrument, commanding, as it does, entertainment from various broadcasting stations, bringing it, in true clearness of tone, to your own fireside. Although a very simple instrument, the Fada receiver-amplifier embodies those true refinements typical of all Fada equipments and parts.

The Fada Handbook will be sent you upon receipt of 5c to cover postage. It's plumb full of things about radio you ought to know. Please mention name and address of your nearest radio or electrical dealer.

F. A. D. ANDREA
1581-D JEROME AVE., NEW YORK CITY

FADA

RHAMSTINE*
RADIO FREQUENCY TRANSFORMER

$4.50

Complete with mounting

Rhamstine* has produced in this transformer every quality which you would naturally look for. In efficiency it is comparable with others costing much more and in design and finish it is doubtful if you can find its equal. Each transformer is equipped with a base mounting and sold at a price exceptionally low as compared with the high value of the unit.

Type 1, 200-500 meters, especially efficient for the present broadcasting services.

Immediate deliveries.

Manufactured by

J. THOS. RHAMSTINE*

2152 E. Larned St. Detroit, Mich.

***Maker of Radio Products**

FREE Radio Catalog

Describes and illustrates our large complete stock of Radio Equipment of all kinds. We can make immediate shipments of proven, reliable equipment. Protect yourself against disappointment by taking advantage of our experience and reliability.

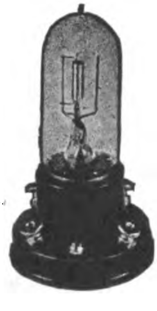
Send $5.00 for Genuine Cunningham or Radiotron Detector Tube

Free catalog sent on request

JULIUS ANDRAE & SONS CO.

In Business since 1860

127 Michigan Street - Milwaukee, Wis.



Na-ald
Special
Socket W. D. 11

Designed especially for the new tube of the Radio Corporation which is operated by a single dry cell. Special clips of phosphor bronze with side wipe and strong gripping action on contact pins. Nickel plated binding screws. Highest quality throughout. Moulded from Condensite.

ALDEN-NAPIER CO.
Dept. C
52 Willow St. Springfield, Mass.

STORAGE BATTERY COSTS ARE ELIMINATED BY USING
SUNECO
TUBE ADAPTER

Which enables you to use the famous dry cell vacuum tube in any radio set socket. Directions:—Insert tube in Adapter, insert Adapter in socket. Tube circuit is automatically adapted to conform to your set. Save time money, and rewiring changes by using this Adapter.

Price $1.50 each

Send money order or cash if your dealer cannot supply you. Dealers write for proposition.

Sun Equipment Co.
Dept. R
67 Exchange Place
New York

Loud Speaker $1
Adapter

$1

Hear all broad-casting through phonograph. Make your own horn. Attach B-R Phonadapter to YOUR phonograph. All can hear. Entire family, neighbors, guests can hear operas, lectures, latest news, with this adapter. Stretches over receiver of Baldwin or Brandes type head-set and attaches to tone-arm of ANY phonograph. Made of soft, pure gum rubber. Quickly attached and removed. Thousands in use. Absolutely no voice distortion. For single receiver.................................... .75

For pair of receivers (more than twice the volume) $1

Amplitone Loud Speaker

An inexpensive, loud speaking horn especially adapted for home use. Ample volume. Quality tones. Throat of horn consists of successive sound expansion chambers. Each chamber amplifies previous one. Furnished either with single or double B-R Phonadapter. Price only.. $8

Bell Horn

A Bell Horn with ball swivel. Turns up, down, to side—any angle desired. Automatic adjustment. Very simple. No screws, thumb nuts, etc. Black finish. Complete, with phone, ready to attach to two stage amplifier............ $15

The Beckley-Ralston Co.
1825 So. Michigan Ave.
Chicago, Ill.

Go to your dealer. If he cannot supply you send money order, check or currency at our risk. Prompt delivery — postpaid. Also send us name of favorite dealer.

Your Christmas will be more enjoyable

With a Crosley Radio Receiving Set

Let the children hear Santa on Christmas Eve. The entire family will enjoy the Christmas Carols and the appropriate Concerts and Dance Music during the Happy Holidays.

Listen in for Crosley Broadcasting. Our new station, WLW, is one of the largest and best in the country, and can be heard in any part of the United States and Canada, east of the Rockies, with a Crosley Model X. This instrument as in all of our larger units incorporates one stage of Tuned Radio Frequency Amplification. We were the first to bring this feature on the market, and have developed it to its highest degree. This simplifies tuning, increases the range and clarity and eliminates interference. Crosley instruments are popular wherever they are tried.

With a Crosley Outfit, you are assured of an enjoyable time every evening in the week. A single wire from your house to a nearby tree or building, is all that is necessary. Connect this to your set and you are ready to tune in any number of stations and hear a wide variety of selections. Easy to install and easy, even for a novice, to operate, a Crosley Receiving Set will solve your entertainment problem.

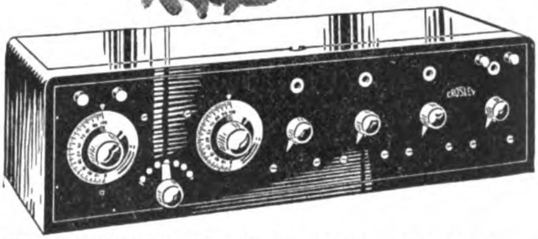
We make any size instrument from $25 up, and all parts necessary to build your own set.

Your jobber or dealer should be able to furnish you with Crosley Apparatus. If not, send us his name and order direct.

WRITE FOR CATALOG

CROSLEY
BETTER·COST LESS
RADIO

CROSLEY MANUFACTURING CO·
Department PR4
Cincinnati·Ohio



CROSLEY RECEIVER MODEL X. A four-tube outfit the same as shown in the above scene. It consists of Tuner, one stage of Tuned Radio Frequency Amplification (the feature that has made our instruments so popular), Detector and Two Stages of Audio Frequency Amplification in a beautiful mahogany finished cabinet. It will bring in distant stations loud and clear. Price without phones, batteries or tubes, **$55.00.**

DIALS

2 in. 20c. 3 in. 27c. 2¾ in. 25c.

With Brass Insert and Set Screw

Specify whether 3-16 in. or ¼ in. Insert

$1.75
"SESCO" Variocoupler
600 Meters

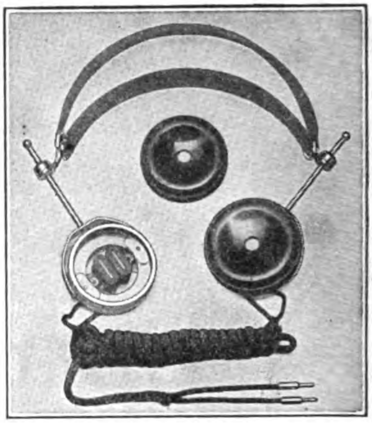
$2.50
"SESCO" Variometer

Standard Mod. 8 Phones, 2500 Ohms, $5.75

Half with order, balance C. O. D.

STANDARD ELECTRIC SALES CO.

843 Broad Street Newark, N. J.



$8 LIST PRICE $8

2,200 OHMS LOUD AND
LIGHT WEIGHT CLEAR

Dealers May Send
$3.20 for Sample

FRENCH MFG. CO., Seymour, Conn.

Speed Up Your Production

by sawing bakelite, formica, brass, copper, carbon, or wood on a

Junior Bench Saw

A precision machine especially adapted to the rapid and accurate production of small duplicate parts. All metal construction. Top 10" x 13", elevates for grooving, tilts 10 degrees for beveling. Saws 1½" stock. Easily driven by ¼ hp. or ⅓ hp. motor. Attachments for grinding and sanding. Special saws for bakelite, brass, etc., furnished from stock.

Junior Bench Saw with guides and one 6" wood saw **$28.75**

Motor Driven Unit as shown, mounted on iron base with ¼ hp. ball-bearing motor, belt tightener, belt, cord, plug, and switch, $60.00. Write for fully illustrated circular.

Manufacturers and amateurs will be interested in our Handilathe, Junior Bench Drill, Handisaw and Ball-Bearing Motors.

W. & J. BOICE, Dept. 612, 114—23rd ST., TOLEDO, OHIO

BUILD YOUR OWN RECEIVING SET WITH

"Scientifically Superior" Radio Supplies

Receiving Combination CR-1 Complete $12.00

100	ft. copperclad aerial wire	$1.00
50	ft. insulated ground wire	.75
2	Midget aerial insulators, each 25c	.50
1	Ground Clamp	.12
1	Inductance coil (150-600 meters)	1.00
1	Crystal detector	1.50
1	Tuning condenser (General Radio)	3.25
1	Pair Murdock head phones (2,000)	5.00
4	Binding posts, each 5c	.20
1	Composition panel 6 by 9	1.00
	Total	$14.32

Expert radio advice free to our customers.

SCIENTIFIC RADIO CO., 112 W. 16TH ST., NEW YORK, N. Y.

HEAR RADIO RIGHT!

Starnes Superadio Specials, same as used in the Harry T. Starnes lecture-demonstrations throughout United States and Canada, in piano finish mahogany cabinets.

Detector, and One Stage Audio Frequency Amplifier	$40.00
Detector, and Two Stage Audio Frequency Amplifier	$50.00
With Automatic Filament Control	$60.00
Two Stage Radio Frequency Amplifier, the best	$75.00

Also High Quality Three Stage Radio, and Audio Amplifiers.

WRITE FOR PRICES

Special 2500-mile Receiver, which caused so much comment on Chautauqua and Lyceum Tours recently $200.00

Also Clapp-Eastham, Westinghouse, Radio Corporation and other high-grade products, at interesting prices.

STARNES SUPERADIO SERVICE Covington, Indiana

NA-ALD

De Luxe

V. T. Socket

Contact strips of laminated Phosphor bronze press firmly against contact pins, regardless of variation in length. No open current trouble possible. Socket moulded from genuine Condensite. Practically unbreakable. Special protected slot, with exterior reinforcement. Unaffected by heat or bulbs or soldering iron. All excess metal eliminated, aiding reception. May be used for 5 Watt power tube. Highest quality throughout. Price, 75c.

Special proposition to dealers and jobbers.

ALDEN-NAPIER CO.

52 Willow St. Dept. C Springfield, Mass.

The Tower of Babel will be Sending this Winter

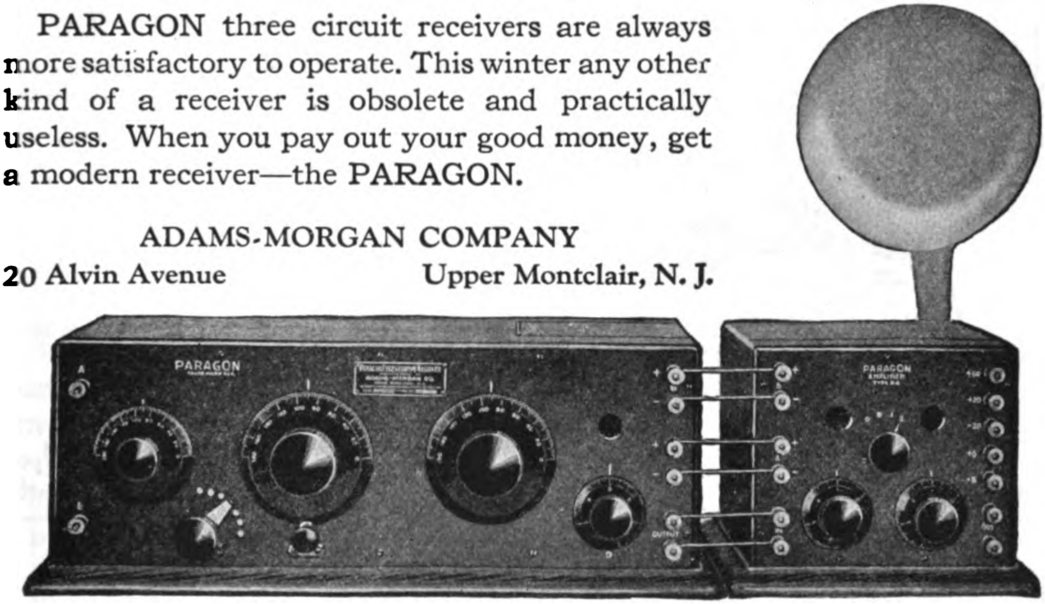
Also Manufacturers of
PARAGON
Radio Telephone Transmitters
V. T. Control Units
Rheostats
Potentiometers
V. T. Sockets
Amplifier Transformers
Detectors
Control Dials
Amplifiers
Receivers
Switches
Variometers

Forty powerful broadcasting stations, all operating on one narrow wave band—that's the situation confronting the radio fan this winter. With the ordinary single circuit it will be like listening in on the Tower of Babel.

The PARAGON three circuit receiver, because of its greatly superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

PARAGON three circuit receivers are always more satisfactory to operate. This winter any other kind of a receiver is obsolete and practically useless. When you pay out your good money, get a modern receiver—the PARAGON.

ADAMS-MORGAN COMPANY
20 Alvin Avenue Upper Montclair, N. J.



Type RD-5 Regenerative Receiver (Including Detector)
Type A-2 Two-Stage Amplifier
(Licensed Under Armstrong Patents)

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

MICON

Tested Mica Condensers

Assure: Absolute noiselessness, Clarity of tone, Accuracy, Constant fixed capacity

Size	Price
.00025	$0.35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.01	1.50

Complete diagram of the Armstrong Super-Regenerative Circuit FREE with every purchase of MICONS.

Sizes .0025 and .005 are especially adapted for the new Armstrong Super-Regenerative Circuit. Micons can be had in all capacities from .000025 to .01.

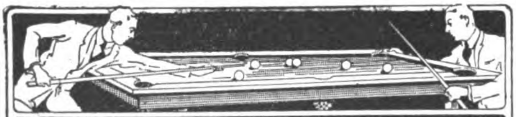
At your dealer's—otherwise send purchase price and the desired Micons will be sent without further charge.

CHAS. FRESHMAN COMPANY, Inc.
290 HUDSON STREET NEW YORK CITY

3000 Ohm Sets $3.98
PLUS 20 CTS. POSTAGE AND PACKING
Satisfaction Guaranteed or Money Back

We mail phones the day your order arrives. Every pair tested, matched and guaranteed as sensitive as $8 to $10 Sets. Circular Free.

TOWER MFG. COMPANY
114 STATION STREET, BROOKLINE, MASS.



BURROWES

Home Billiard & Pool Tables

Magnificently made in all sizes, at all prices. Game exactly same as standard table. Become expert at home. Use in any room, on any house table or on its own folding stand. Quickly leveled. Put up or down in a minute. Small amount down, easy payments. Ask your dealer or WRITE TODAY for Catalog.

E. T. BURROWES CO., 150 Free St., Portland, Maine

RADIO & AUTO STORAGE BATTERIES CHARGED FROM A LAMP SOCKET AT HOME At a Cost of a Few Cents With An

$15

Charges AUTO & RADIO Batteries.

F-F BOOSTER

Full Wave Automotive Magnetic Charging Rectifier for 105-125 Volt, 60 Cycle, A. C., Type A-B Charges, 6 Volt, "A" and Auto and up to 120 Volts, of "B" and Loud Speaker Storage Batteries, in Series Inductively at home overnight. Disconnecting and Multiple Connections Unnecessary. Charging Circuits Separate. No Grounds. No Danger. No Skill Required. AMMETER eliminates Guesswork. Infusible Electrodes Rectify Current. Will Charge a Dead Battery. Leave Battery Connected, Screw Plug in Lamp Socket, Snap Rectifier Clips on Battery Terminals, Turn Switch and Battery is Charged in Morning. Nothing like it made. Is it not gratifying to feel your Radio Batteries are ready for all Radiophone Music and News? Never having to be careful of, or tell friends your Batteries are Dead? Fully charged Batteries by starting car quick, require fewer expensive replacements. Do not think your Battery is Dead and Worn Out because it will not start your car. Buy a Booster which fills it with life, saves more than its cost and lasts a lifetime. 7 types built by Master of the Art and POPULARLY PRICED.

Type 6 Charges Radio "A" & Auto 6 V. Batteries at 6 Amp...	$15
Type B Charges Radio "B" Batteries up to 120 V. in Series	$15
Type A-B Charges "A"&"B" Radio & Auto Batteries in Series	$20
Type 12 Charges 12 Volt Batteries at 5 Amperes........	$15
Type 166 Charges 6 Volt Batteries at 12 Amperes........	$20
Type 1612 Charges 12 Volt Batteries at 7 Amperes......	$20
Type 1626 is Combination of 166 & 1612 Charging 6 & 12 V.	$28

The Larger Types are for heavy Batteries, or where time is limited. Shipping Weights, 11 to 15 Pounds. Purchase from Your Dealer, or Send Check for Prompt Express Shipment. If via Parcel Post have remittance Include Postage & Insurance charges. Or have us ship You Type desired C. O. D. Other F-F BATTERY BOOSTERS Charge Batteries from Farm Lighting Plants and D. C. Circuits. For GROUP CHARGING use our 100-Volt Automatic ROTARY RECTIFIER, 12 Battery, 8 Ampere Size, $135. ORDER Now or WRITE Immediately For FREE BOOSTER BULLETIN 44 and ROTARY 44A.

THE FRANCE MFG. CO., OFFICES & WORKS: CLEVELAND, OHIO, U. S. A.
Canadian Rep: Battery Service & Sales Co., Hamilton, Ontario, Canada

Agents

LARGE MANUFACTURER OF SHIRTS wants Agents to sell complete line of shirts direct to wearer. Exclusive patterns. Big values. No capital or experience required. Write for free samples.

MADISON SHIRT MILLS
507 Broadway, New York, N. Y.

RADIO Complete Set $15 Down $10 per Month

Send for circular describing the SENSITONE Long Distance Armstrong Regenerative Radio Receiving Set, which we sell, complete with batteries, tubes, head set and aerial—all ready to listen to concerts—on easy payments. Enjoy the pleasure of radio while paying for a Sensitone.

Harold R. Wakem & Co. 851 Washington Blvd., Chicago

35c EACH 3 FOR $1.00

NA-ALD

genuine
CONDENSITE DIAL
The dial that runs true

Numerals engraved on bevel and knob so shaped that fingers do not hide them. Thin edge with clear graduation to make accurate reading easy. Concealed set screw in metal insert. Will not warp or chip. Finish and enamel permanent.

3" dial, 35c.
2" dial for rheostat potentiometer use, 35c.
3⅞" dial, 75c.

Send stamps for complete literature.

ALDEN-NAPIER CO.
52 Willow St. Dept. C Springfield, Mass.

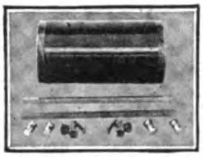
BRILLIANTONE RADIO PRODUCTS

Dept. C—874 Columbus Avenue, New York

$1.00 Brings any one of these Combinations quickly to you

No. 1

100 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lightning switch.
20 Feet No. 14 weatherproof insulated lead-in wire.

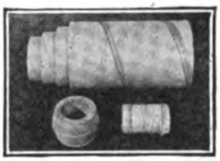


No. 2

1 Wound Enameled wire coil, 8 inches long, 3½" Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.

No. 3

2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detector stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.



No. 4

1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches in diameter.

1 Spool No. 24 cotton covered wire, 375 feet.

1 Hardwood Rotor.

All the above merchandise guaranteed or money refunded.

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PLEASE CHECK BEFORE ITEMS DESIRED—FILL IN COUPON AND MAIL

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

☐ B.R.P. Rheostats, fibre base (Tapered Type)	$ .50
☐ B.R.P. Rheostats, porcelain base	.75
☐ B.R.P. Potentiometer (200 ohms)	1.00
☐ B.R.P. Moulded Sockets (unbreakable)	1.00
☐ B.R.P. Audio Frequency Transformers (11 to 1)	4.00
☐ B.R.P. Radio Frequency Transformers (150 to 500 M.)	3.00
☐ B.P.R. Variometer (to 800 meters)	3.00
☐ B.R.P. Variocouplers (Panel and Laboratory Type in one)	3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

☐ 3 Plate, capacity .00005	$1.50
☐ 7 Plate, capacity .0001	2.00
☐ 11 Plate, capacity .0003	2.50
☐ 23 Plate, capacity .0005	3.00
☐ 43 Plate, capacity .001	3.50

TYPE "B"—ALUMINUM ENDS

☐ 3 Plate, capacity .00005	$1.00
☐ 7 Plate, capacity .0001	1.25
☐ 11 Plate, capacity .0003	1.50
☐ 23 Plate, capacity .0005	1.75
☐ 43 Plate, capacity .001	2.25

BRILLIANTONE RADIO PRODUCTS

Dept. C, 874 Columbus Avenue, New York

STANDARD MERCHANDISE AT REDUCED PRICES

☐ $4.50 Thordarson Amp. Transformers (Audio)	$3.00
☐ $7.00 UV712 Audio Frequency Transformers (Radio Corp.)	6.00
☐ $6.50 UV1714 Radio Frequency Transformers (Radio Corp.)	5.50
☐ ZETA Radio Frequency Transformer	3.50
☐ Brandes "Superior" (2200 ohms)	6.75
☐ Murdock (3000 ohms)	5.00
☐ Federal (2200 ohms)	6.50
☐ Klosner Vernier Rheostat	1.00
☐ Bradleystat (Best Vernier)	1.65
☐ Jacks, single, open or closed (Firth)	.35
☐ Jacks, double, closed (Firth)	.50
☐ Plugs, bulldog grip (Firth)	1.00
☐ .002 and .005 Mica-Bakelite Condensers	.25
☐ .0005 and .00025 Condensers with Var. Leak	.25
☐ .0005 and .001 Fixed Mica-Bakelite Condensers	.20
☐ Two-Slider Tuning Coil (mounted)	1.50

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Enclosed find money order for articles ordered. I agree to pay parcel post charges when delivered.

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WHETHER you require two binding posts, a simple crystal set, or one of the standard tube sets with amplifier and loud speaker, you may obtain it *at the right price* at any radio shop displaying the Sorsinc sign. There is a skilled radio man on hand to advise you, too.

"It Pays to Buy at the Sorsinc Store"

Mr. Dealer:—If you are a progressive merchant you may display the Sorsinc sign. Let us tell you how.

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SORSINC *Branches:*

Boston, 46 Cornhill St.	**San Francisco, 591 Mission St.**
Baltimore, 11 N. Eutaw St.	**Chicago, 538 So. Dearborn St.**
New Orleans, 740 Union St.	**Seattle, 67 Columbia St.**

NA-ALD

Small Space

V. T. Socket

35c. each 3 for $1.00

Moulded genuine condensite. Requires but small space for mounting. Readily accessible binding posts. No excess metal to interfere with efficiency. Unaffected by heat of bulbs or soldering iron. Phosphor bronze contacts. Nickel plated brass binding screws. Slash cut slot. Price possible because of large production.

Special proposition for dealers and jobbers.

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RADIO EQUIPMENT
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(No Antenna or Aerial Needed)

Does away entirely with antenna and all outside wiring, lightning arresters, switches and all other inconveniences.

ANTENELLA enables you to enjoy Radio pleasures in any room in your house. Place your receiving set anywhere and merely attach Antenella to any electric light socket. No current consumed.

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CRYSTAL RECTIFIER

MULTIPOINT
(Patent Pending)

A synthetic CRYSTAL DETECTOR sensitive over its entire surface

Eliminates all detector troubles. 50% increase in clearness and volume. Endorsed by Radio experts and press. Awarded certificates of excellence. Sets a new standard of efficiency.

Price postpaid, mounted Sensitiveness guaranteed **50c**

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INCREASE YOUR RANGE—
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Size, ⅝x2½ inches. Suitable for "test tube B batteries" and experimental work. These plates have cast alloy grids and are made in the best possible manner.

"B" STORAGE BATTERIES

24, 50 and 100 volts; or any voltage made to order. Oil sealed. Write for illustrations.

J. A. RITTER LANSDOWNE, PA.

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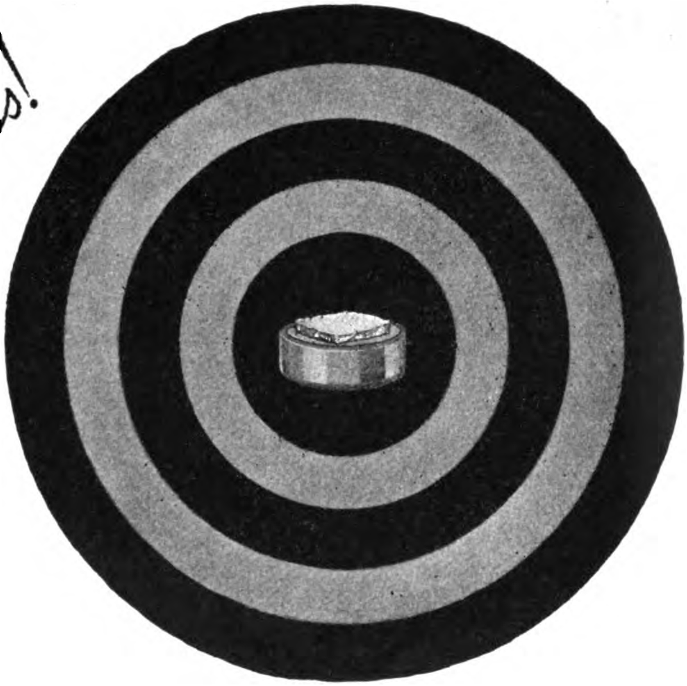

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Good results depend upon your hitting the super-sensitive spot of a sensitive crystal. There's only one way to be sure of good results, and that's to be sure you're using the right crystals.

It's mighty annoying to waste time (and entertainment!) because of worthless crystals.

Hit the bull's eye the first time and every time. Play safe, take no chances—use the original, proven crystals —the "NAA" Arlington Tested brand. Each "NAA" is selected from *sensitive bulk stock,* and is *individually tested* and guaranteed super-sensitive.

"NAA" Galena, Silicon or Goldite: Price per crystal, individually packed—$.25.

Mounted crystals, set in Wood's metal in brass cup, $.40. At your dealer's, or direct postpaid.

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Also producers of the famous "Red-Head" Radio Receivers and the Teagle line of *Better* Radio Equipment.

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COGSWELL Variable Condenser

Most advanced design, with highest quality material and workmanship thruout.

Duraluminum end plates; pig tail connection. Accurate plate alignment, convenient binding posts and genuine Condensite Na-ald Dial. Bent or shorted plates unknown in this condenser.

Prices range from $2.50 for 3 plate Vernier with dial to $4.70 for 43 plate Precision.

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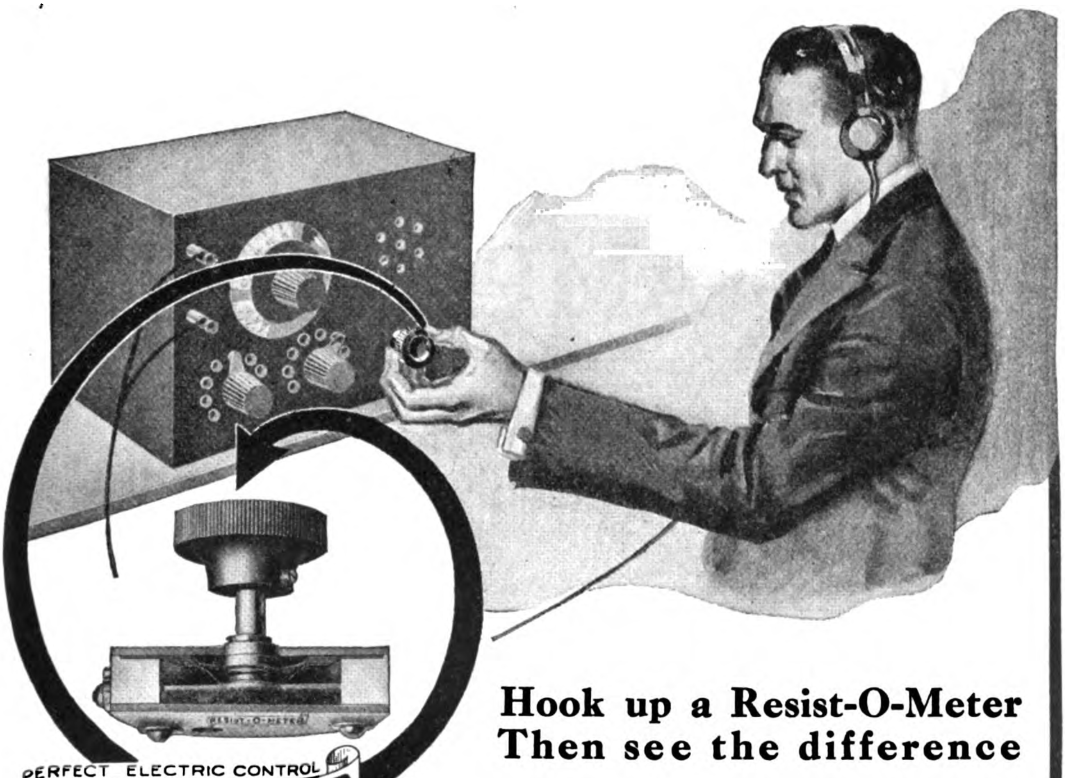

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TRADE MARK

The Resist-O-Meter illustrated is Type A Filament. Price, ***$1.80***

We manufacture the products listed below:

Resist-O-Meters

Type A—Filament
" B—"B" Battery
" C—Potentiometer
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Test-Rite Condensers in following capacities:

Phone	.001	mfd.	
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Hook up a Resist-O-Meter Then see the difference

A VARIABLE resistance that *is* variable, not by a series of steps or by a sliding contact, but continuously between the extreme ranges of its terminals without a break, micrometer controlled for accurate adjustment of proper current values of the "A" and "B" batteries.

This ideal has been developed—The Scholes Resist-O-Meter.

This Scholes Resist-O-Meter possesses the following additional and essential advantages:

1. It is non-microphonic.
2. It possesses the lowest resistance at full compression (almost zero).
3. It is made in models giving various ranges of control previously not attained (covering every requirement for radio use).
4. It is made in compact and conventional form requiring minimum room for mounting.

The Scholes "Resist-O-Meter," in principle, has been used for more than seven years in electro-chemical processes in which exceedingly accurate and constant current control is required.

This apparatus, simple in the extreme, has been refined and perfected to adapt it to the minute currents and sensitiveness of control needed for radio work.

The Scholes Radio and Manufacturing Corporation hold the sole license to manufacture this type of radio rheostat. It is sold only under the name "Resist-O-Meter," and fully protected by patent and trade mark rights. Your dealer will supply it. Ask for the Scholes Resist-O-Meter.

Write Mr. C. W. Preston

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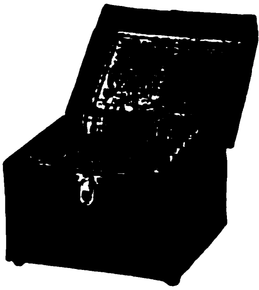
Increase the Range of your AERIOLA SR. with the new AC AMPLIFIER



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Complete with 2 WD-11A vacuum tubes (without batteries)
$68.00

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Model LV
$30.00

THE new A C Amplifier, to a considerable extent, increases the reception possibilities of the Aeriola Sr. With head telephones and the A C Amplifier reception ranges of one hundred to three hundred miles become possible for the owner of an Aeriola Sr., depending on local conditions. Used with the Vocarola loud-speaker, the Aeriola Sr. and A C Amplifier fill a whole room with music and speech received over distances of ten to thirty miles.

Anybody can make the simple connections required, including mother and the girls.

See this New Amplifier at Your Dealer's

This symbol of quality is your protection

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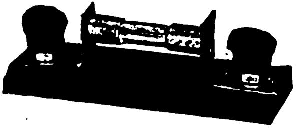
Products Give Satisfaction

TELERADIO SUPERSENSITIVE PHONES TYPE C, $6.50. The performance of a pair of phones is what really counts. Write for our trial offer. Type B, **$7.50**—Type A, **$9.00.**



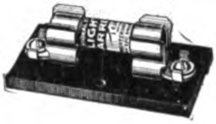
TELERADIO FILAMENT PROTECTOR

Here is the cheapest vacuum tube insurance you can buy.

The Teleradio Tube Protector complete sells for 60c and extra fuses for 10c apiece. Not much to pay when you figure that each time you blow out a 10c fuse you save the price of a $5 or $6 tube.

TUBE SOCKET

A well-constructed, durable socket. Shell made of drawn aluminum. Hygrade insulated base. Legs not current carrying. Contacts made of phosphor bronze. All parts nickel-plated.



TELERADIO LIGHTNING ARRESTORS

Approved by National Board of Fire Underwriters.

Electrical No. 5837
The only approved arrestor that retails at $1.

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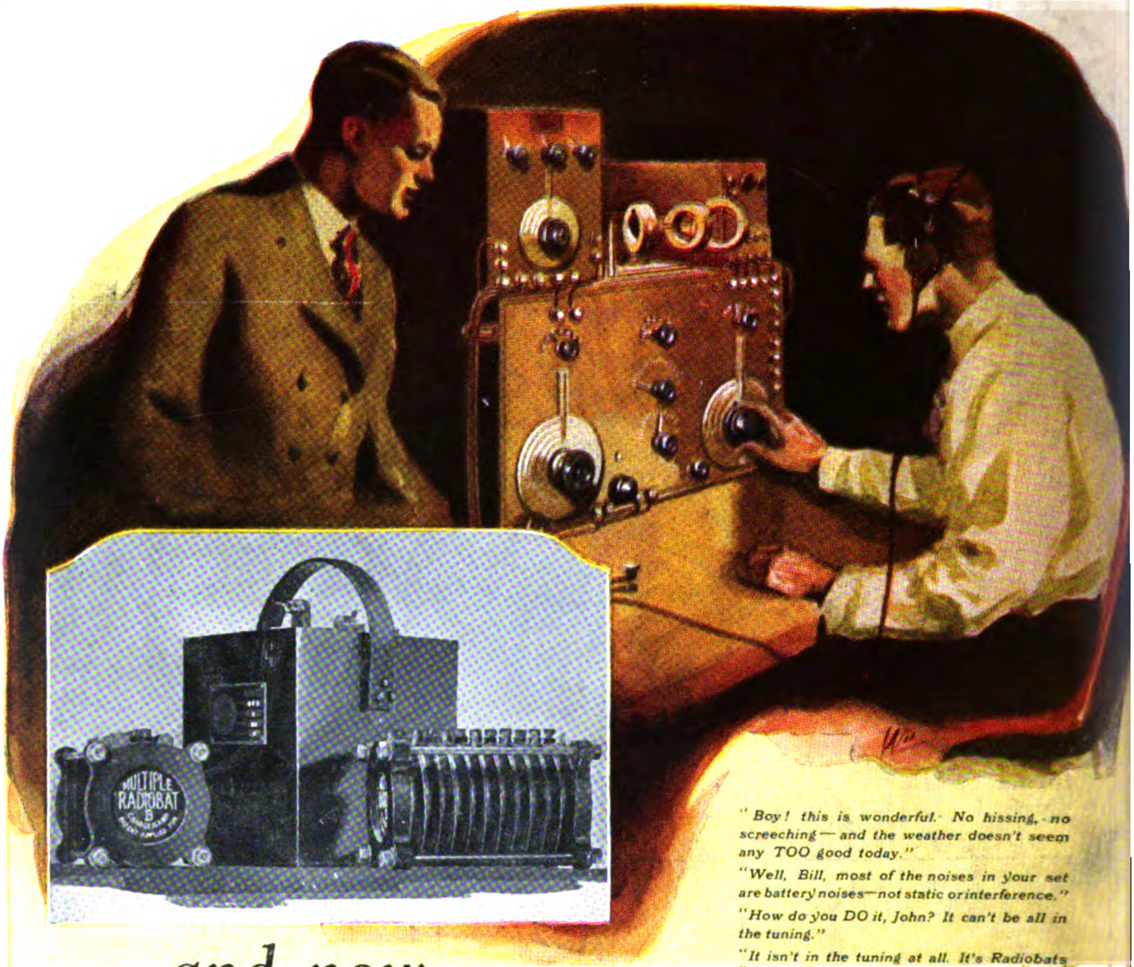

"Boy! this is wonderful. No hissing, no screeching—and the weather doesn't seem any TOO good today."

"Well, Bill, most of the noises in your set are battery noises—not static or interference."

"How do you DO it, John? It can't be all in the tuning."

"It isn't in the tuning at all. It's Radiobats "A" and "B". Try 'em and HEAR"!

—and now harmony replaces discord!

MUSIC—clear as a bell; speech—every word is marvelously distinct; jazz—uninterrupted syncopation; opera—with full-toned quality and beauty in strong relief.

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Irregular voltage output, natural in ordinary "B" batteries, causes noises. Unvarying current output stops these noises—and this marvelously clear and life-like reception results.

Because RADIOBATS "A" and "B" are the only batteries *able* to act *correctly,* we urge you to listen to a demonstration at your dealer's.

There *is no* way to hear such reception till these new-principle batteries are hooked in.

RADIOBATS "B"—as well as "A"—are *leak-proof because they have the only solid electrolyte;* and are more economical, because, like "A" Batteries, they are indefinitely *rechargeable at home.*

Send your dealer's name and address that we may arrange an immediate demonstration.

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